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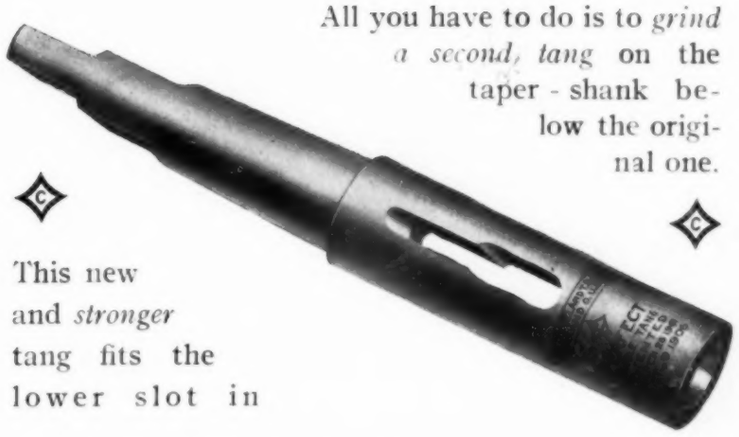

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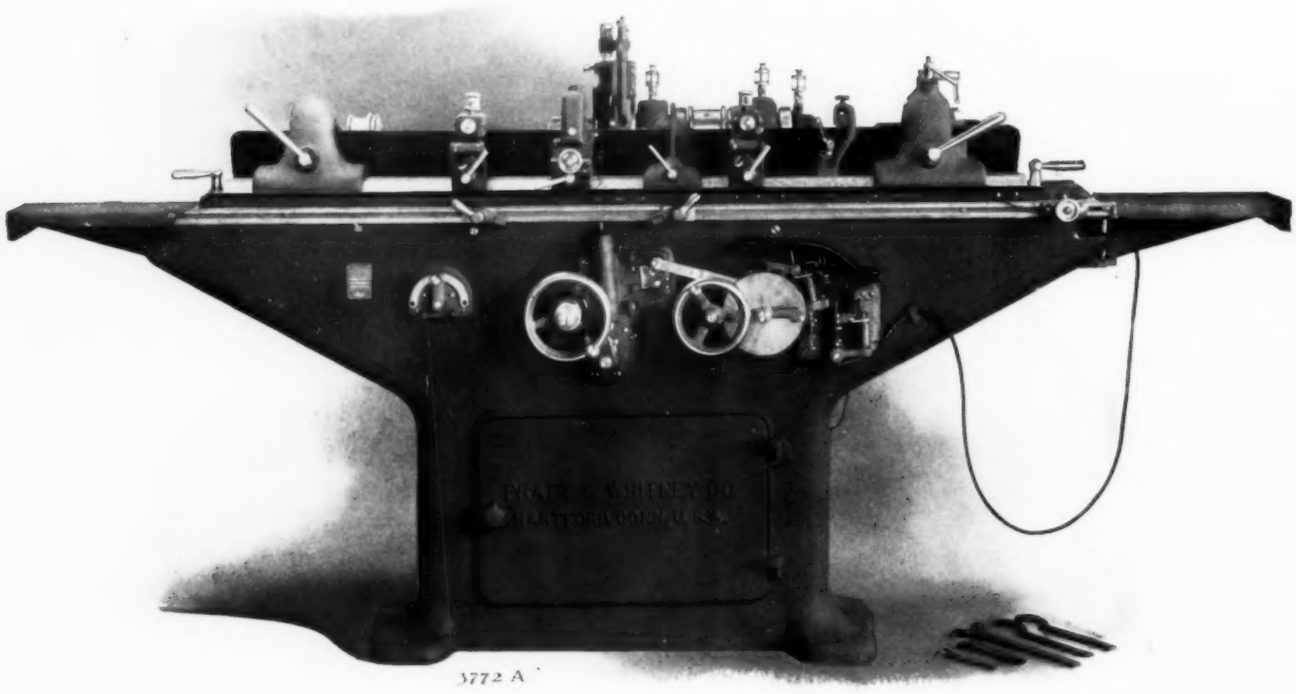

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The Glocker-White Turbine Governor

Hollow Balls Containing a Shifting Charge of Mercury Introduce Exactly the Properties Required in Water Wheel Governing

BY W. M. WHITE * AND L. F. MOODY †

Before explaining the principle upon which this governor acts, it is necessary to outline the difficulties connected with the regulation of large water-wheel units. Unlike the steam in the supply pipe of an engine, the water in a penstock is possessed of a large amount of inertia, which makes it impossible to deal with the water as one would with steam; that is, reduce or increase its flow at will. If the flow is abruptly reduced, the effect known as water hammer is brought about, and with the large capacities and high heads of existing plants this may very easily burst the pipe. Added to this is another action which momentarily reverses the intended effect if the gate is suddenly operated. If the gate is partially closed with a sudden movement, the effect of the energy of the moving water in the penstock is to increase the velocity through the remaining opening, to a degree which, if the closing is sudden enough, may actually, for the moment, increase the speed of the wheel instead of decreasing it as would be expected. An abrupt opening of the gate is followed by an opposite effect, the velocity through the enlarged opening being, for the moment, reduced and the speed of the wheel with it.

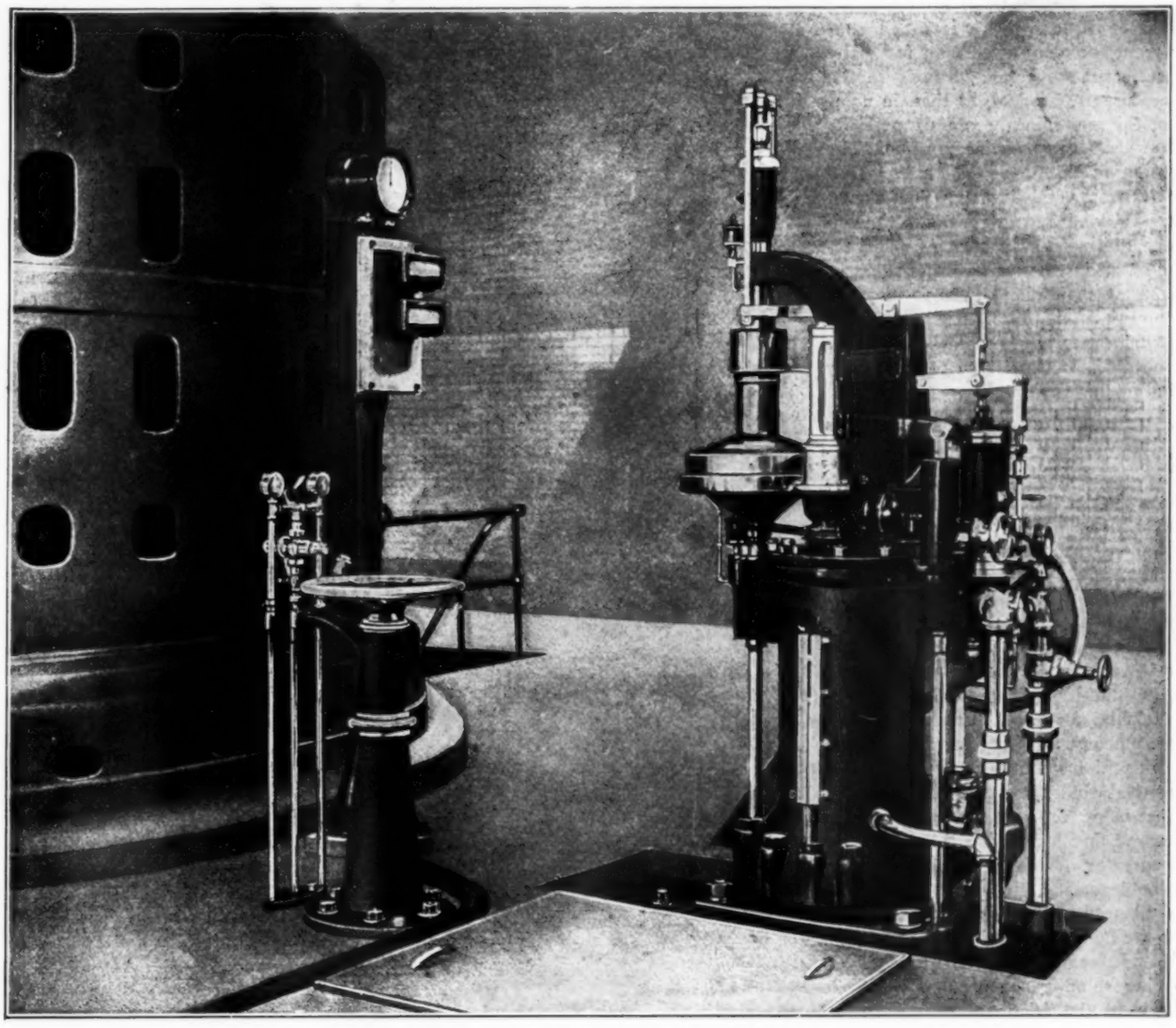

FIG. I. THE GLOCKER-WHITE TURBINE GOVERNOR

It is, of course, desirable that a water-wheel be regulated as closely as a steam engine, and it is entirely possible to do this after the water has had time to adapt its velocity to the varying opening of the gate, but it is impossible by means of the governor alone to provide as quickly for changes of load with water-wheels as with steam engines. In other words, in water-wheel governor designing it is necessary under the usual conditions to abandon at the start the attempt at close regulation through quick movement of the gates; and to introduce an interval of time between a large change of load and the recovery of the speed to the normal figure.

Action under Actual Conditions

While this seems in the stating of it a serious defect, it ceases to be so under ac-

*Chief engineer, hydraulic department, I. P. Morris Company.
†Assistant to Mr. White.

tual conditions. The difficulties introduced by long penstocks are counteracted by the fly-wheel effect of the revolving parts of the generator and turbine, which tends to maintain the speed constant under sudden variations in load until the governor has had time to move the turbine gates and to bring the water in the penstock to the required velocity. In certain high-head installations having long pipe lines and high-speed units, it is necessary to equip the turbines with fly-wheels and relief valves to make close regulation possible. In such a plant as the one to be described, however, the enormously heavy revolving parts possess sufficient inertia to enable the governor to regulate the units without difficulty. Large electric plants, such as those for which the governor to be described is intended, supply current for many users and for many purposes, and the actual changes in the load are usually gradual, so that, in point of fact, the governing becomes practically equal to good steam-engine practice. The real effect of this design is to introduce a safety feature against possible abrupt changes of load and at the same time to combine the essential properties of a sensitive and an insensitive governor; that is, the accurate regulation of the former and the stability of the latter, the hunting action which naturally goes with sensitive governors of the usual type being entirely avoided in this design.

A Plant to Which the Governor Has Been Applied

It should be understood that this governor is a special design, intended for special conditions. It is necessarily an expensive construction and not intended as a competitor of the many excellent commercial governors on the market. Governors of the type shown were applied to the four 13,000-horse-power and the two 500-horse-power turbine wheels, designed and built by the I. P. Morris Company, of Philadelphia, for the Electrical Development Company, of Ontario, Canada. In this Niagara installation the turbines are on vertical shafts and are located about 150 feet below the power-house floor, the governor being located on this floor near the generator. The water-wheels are of the double casing, double runner, single draft-tube type, having cylinder gates, which are operated by levers and rods, the weight of these gates, levers and rods aggregating some 15,000 pounds, which, in addition to the frictional resistance and hydraulic pressure on the gates, must be handled by the governor. The weight of these parts is made to close the gates, the governor being of the one-way type; that is, the cylinder which, by means of high-pressure oil, operates the gates, and which is controlled by the governor, is single acting, the pressure being used to open the gates only, while the escape of the contained oil from the cylinder is made to control the action of the heavy parts in closing the gates.

The Operation of the Governor

Fig. 1 shows the governor as installed with its generator at the left, and Fig. 2 is a section of the revolving element. In order to give a general idea of the principle on which the governor operates, it may be explained that the revolving element, which is geared to the turbine shaft by a positive drive, is the part of the governor which responds to changes of speed of the turbine and directs what position the turbine gates should occupy. It does this by moving the sleeve *i*, Fig. 2, on the central spindle and with it the floating lever *a*, Fig. 4, as will be explained below.

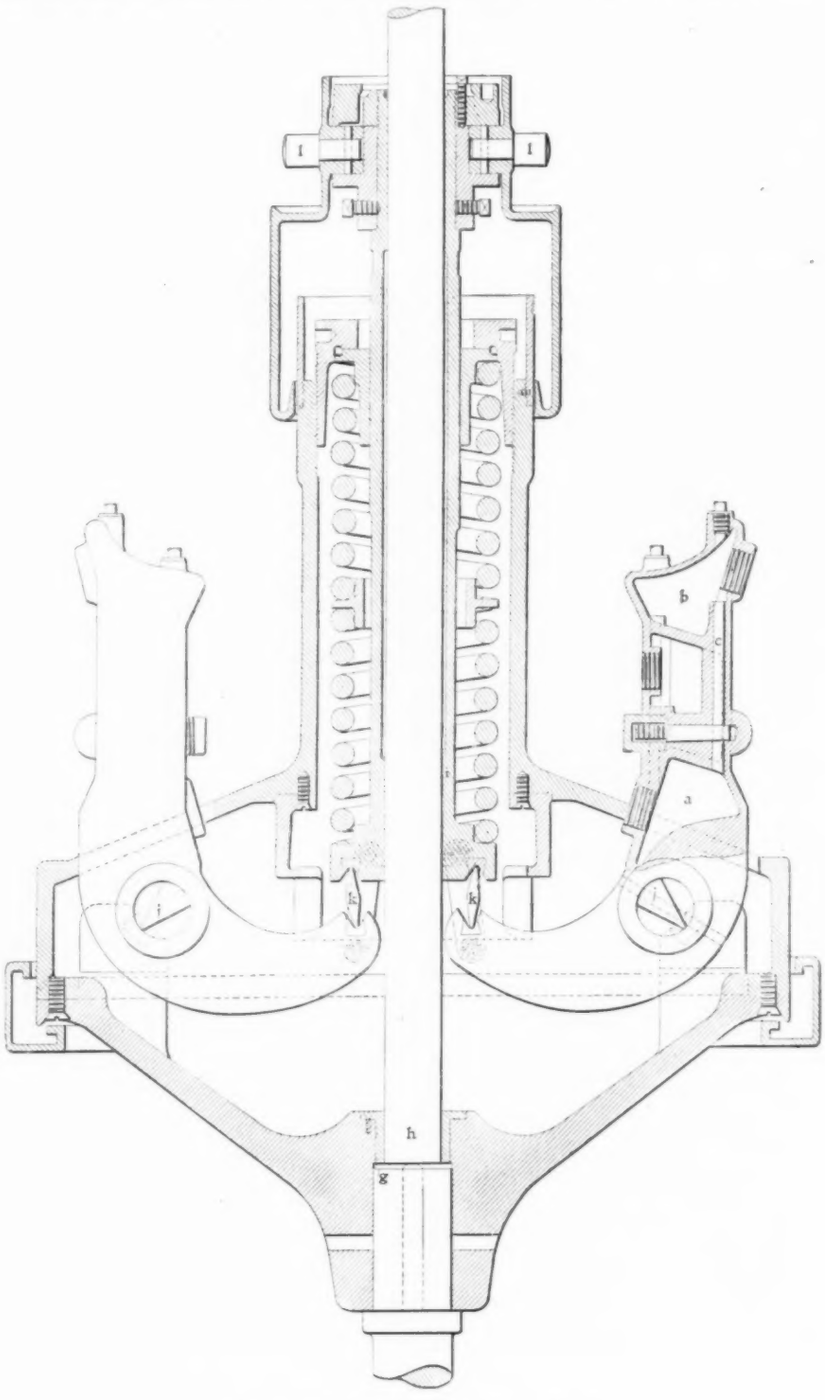

FIG. 2. SECTION OF REVOLVING ELEMENT

The function of all the rest of the mechanism of the governor, shown in Fig. 4, is simply to move the gates into a position corresponding to that occupied by the sleeve *i*, and to keep them there until *i* is moved again. When the fly-balls or arms, Figs. 2 and 3, are vertical, the sleeve *i* and the turbine gates are in mid position; when the arms approach the center of revolution, due to a decrease of speed, the sleeve moves downward and the governor mechanism opens the wheel gates an amount proportional to the movement of the sleeve; when the arms fly outward, on account of an increase of speed,

the sleeve rises, and the wheel gates close a corresponding amount. With the arms in their inner extreme position, the wheel gates are wide open; with the arms in their extreme outward position, the wheel gates are closed.

Mercury-charged Governor Balls

The most novel feature of the governor is shown in Fig. 2; that is the hollow and peculiar shape of the arms. This feature is, however, shown to a larger scale in Fig. 3 which is a detail of an arm, and shows two chambers, *a* and *b*, connected by a passage *c*, which is intercepted by a plug *d*, having a small hole *e* drilled through it. Into the lower chamber a charge of mercury is placed, and it is the action of this mercury as the arms change their positions which gives the governor its peculiar properties. The normal speed of the governor is 500 revolutions per minute, under which speed the action of centrifugal force is so much in excess of that of gravity that the tendency of the mercury is to assume a position with its free surface nearly vertical instead of horizontal, the theoretic curve of the surface being a paraboloid of revolution; and, under this condition, if the arm is vertical, as it is at normal speed, the mercury will flow through the passageway and be divided between the upper and lower chambers, an air passage *f* permitting free flow. With the mercury in this position and the arms revolving at normal speed, the centrifugal force is just sufficient to balance the action of the spring and maintain the ball in the vertical position. Should, however, the speed increase and the balls move outward, the mercury will partially or wholly move to the upper chamber at a rate determined by the size of the opening *e*, in the plug *d*, while if the speed is reduced and the balls move within the normal position, the mercury will be partially or wholly transferred to the lower chamber.

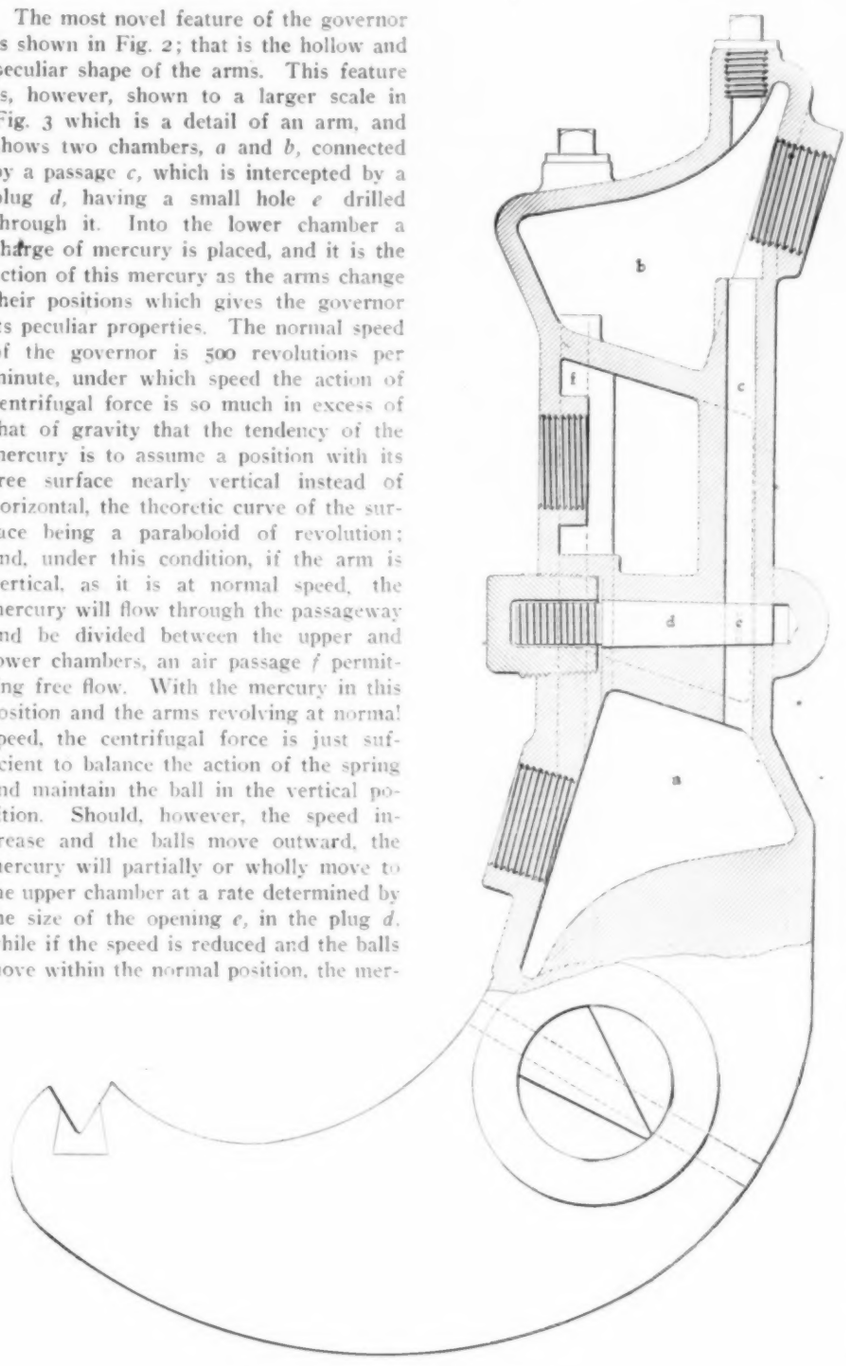

FIG. 3. SECTION OF A GOVERNOR BALL

The Object of the Mercury Charge

If, with the mercury distributed as at normal speed, the passageway *e* could be closed, the governor is so proportioned that it would have a sluggish action, an increase of 50 revolutions per minute being necessary to move the arms to their outer position, and a decrease of 50 revolutions to bring them to the inner position. Under these conditions and without additional compensating devices, the speed would vary from 450 to 550 revolutions from full to no load—this initial sluggish action being the safety device to prevent the water-hammer action.

With the passageway open, however, the action under such an instantaneous throwing off of the load is to make this increase in speed momentary only. With the changed position of the balls the mercury begins to shift its position from the lower to the upper chamber. The centrifugal force of the arm and its charge is increased, less speed is required to maintain sufficient pressure to balance the spring and the speed gradually returns to the normal, or very near it. In the governor shown, the shape of the chambers is such that when permanent conditions are re-established, the speed is brought to 495 revolutions under full load, and 505 under no load. The quickness of the recovery is obviously determined by the size of the hole *e* or the adjustment of the plug *d*. This time of recovery is fixed to suit the time required to operate the gates, which in turn is dependent on the length of penstock and on other conditions. It may be remarked in passing that the shape of the chambers is a matter of the greatest nicety and one which it is difficult, if not impossible, to work out mathematically, the shape shown having been arrived at after many preliminary experiments. It is entirely feasible so to design the shape of the chambers as to make the governor perfectly isochronous, or even to make the speed of the turbine considerably higher at full load than at no load, which produces an effect similar to overcompounding a generator in electrical practice. In ordinary practice, and necessarily when the turbines drive alternators, the no-load speed is higher than the full-load speed by a definite amount.

As has been explained, with plants of the size which we are considering, the instantaneous application or release of the load seldom occurs. Under actual conditions the movement of the mercury is nearly in unison with the change in speed, being adjusted to lag slightly behind the speed change, so that after the initial movement of the arms caused by a sudden change of load, the flow of mercury will keep step with the change in speed, the arms remaining nearly stationary until the regulation is almost completed.

Absence of Static Friction

An interesting feature in the design of the revolving head is the entire absence of friction of rest. Thus, referring to Fig. 2, the driving shaft is cut off at *g*, the spindle *h* being supported stationary at its top end, sleeve *i* revolving upon it. The reader will recall how readily a heavy revolving shaft having end play, such as that of a motor or generator, may be moved in its bearings while in motion, although to move it when standing still would require considerable effort. The mounting of the revolving sleeve upon a stationary shaft is an application of the same principle, and gives the governor at this point entire freedom. In addition to this, all moving parts are fitted upon knife edges, as shown at *j* and *k*.

The Relay Apparatus

The control of a gate apparatus weighing 15,000 pounds, to say nothing of the

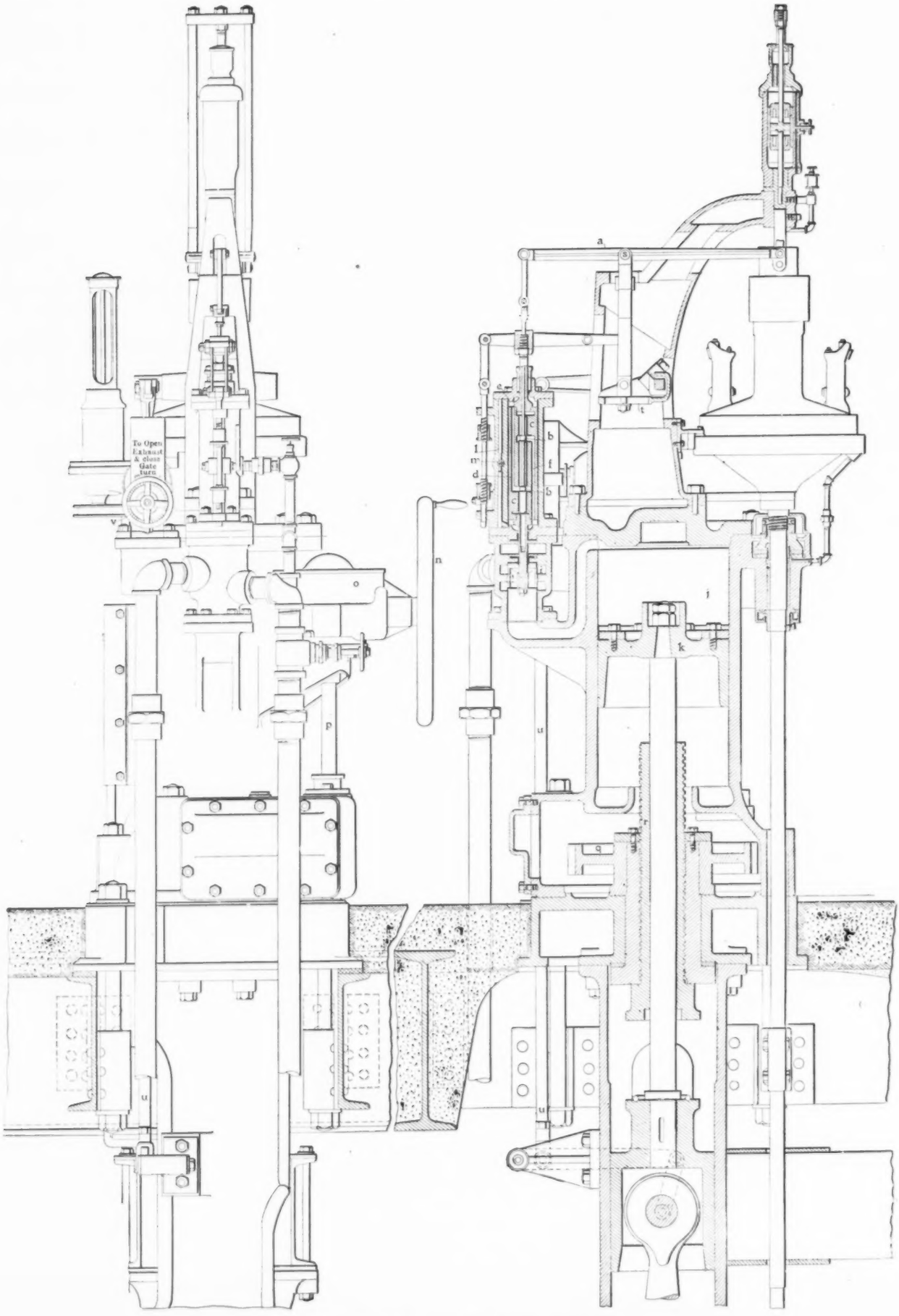

FIG. 4. SECTIONAL ELEVATION OF ENTIRE GOVERNOR

rushing torrent of water, by such a delicate piece of apparatus, is, of course, only possible on the relay principle, and, as a matter of fact, in this case the gate control includes a double relay. The mere shifting of the valve for the main gate-controlling cylinder by the governor direct would impose altogether too heavy a load on the balls, and hence this valve is controlled by a supplementary piston, of which the valve is in turn controlled directly by the governor balls. The pistons operate under oil pressure at 250 pounds per square inch.

Fig. 4 shows the entire governor, except for the revolving element, in section, the rising and falling of the sleeve *i* of Fig. 2, which, as shown in Fig. 4, is fitted with a dashpot at the top, being made to connect with lever *a*, Fig. 4, by means of pins *l*, Fig. 2. This lever connects with the pilot plug valve *b* of ¾ inch diameter, by which the gate is primarily controlled. The valve works in a long piston *c* having its own valve seat within it, as shown. The pressure oil is admitted to the space between the valve-plug heads, as shown in Fig. 5, which is a section at right angles to the one shown in Fig. 4. Assuming the speed to increase from a reduced load and the balls to go outward, the result will be to depress the valve *b*, and thus admit oil to the port *d*, Fig. 4, and to the upper end of the cylinder at *e*. At the same time the exhaust oil from the lower end of the cylinder will be discharged through the ports *f*, Fig. 4, and *g*, Fig. 5. Under this action the piston will go downward and thus close the port *d* just opened by the lower head of the pilot valve—the piston following the movement of the pilot valve and of the governor balls exactly as though attached to them mechanically, except, of course, after a small lapse of time.

Piston *c* is connected with the main valve *h*, as more clearly shown in Fig. 5, and, obviously, the sinking of piston *c* thus opens port *i* and permits the oil in the cylinder *j*, Fig. 4, to escape and the piston *k* to rise under the weight of the gate parts and thus to close the gate.

Equalizing Mechanism

With the mechanism arranged as described, and without any additional attachment, a movement of the governor sleeve and the end of the floating lever *a* would simply open the admission or exhaust connections of the operating cylinder *j*, and the gates would move to the extreme end of their stroke. In order that the motion of the gates should cease when they have reached a position corresponding to that of the governor sleeve, the fulcrum *s* of the lever *a* is not fixed, but movable, being attached to the equalizing mechanism, which includes the rocker arm *t* and the rod *u* geared to the wrist pin of the gate mechanism. By means of this mechanism, when the gates have moved a sufficient amount, the fulcrum pin *s* moves the floating lever *a* and restores the pilot valve *b* to its neutral position, stopping the motion of the gates.

By altering the adjustment of the equalizing mechanism the position of the gates can be altered while the rest of the governor mechanism remains in the same

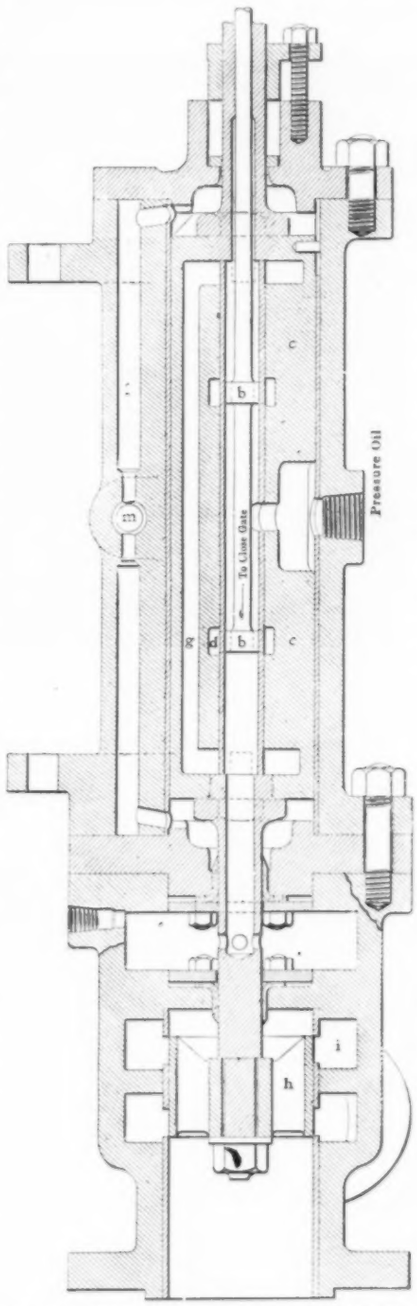

FIG. 5. ENLARGED SECTION OF SUPPLEMENTARY PISTON AND VALVE

position; in other words, the governor can be made to regulate the turbine at a different speed. This adjustment can be altered by turning the small hand-wheel *v*, and can be controlled from a distant point such as the switchboard by means of a small motor. This distant control is useful in starting and synchronizing the units. An adjustment of the effective length of the rocker arm *t* is provided for the purpose of altering the variation between the no-load and full-load speeds.

A passage *l*, Figs. 4 and 5, closed by a plug cock *m*, connects the two ends of the first cylinder, its office being to throw the governor out of action by opening the cock in order to permit the operation of the gate by hand. This operation of the gate is accomplished by the hand-wheel *n*, Fig. 4, which, by means of bevel gears within the casing *o*, turns the shaft *p* and thus the gear *q*. The hub of tnis gear is threaded internally and operates the screw *r*, which is mounted upon the gate rod. It will be understood, of course, that this rod is connected to the actual gate mechanism by a lever not shown, which reverses its motion, the pressure of the oil on the upper side of the piston *k* serving to lift the gate and its escape to close it as already described. The gates may also be operated by hand control of the oil admission to the upper valve.

The governor as a whole is seen to be a complicated piece of machinery. Much of this complexity is made necessary by the large number of adjustments required, and by the nature of the operation of governing, which is so far from simple that such a governor as this has been thought to display almost "human intelligence." That the large number of the working parts has not interfered with the operation of the governor is proved by its very successful actual performance.

Case-hardened Cast-iron Gages

By P. H. Crosby

I think that cast iron case-hardened should find a more prominent place in the making of gages than it does, owing to its cheapness of manufacture and efficiency when in use, as with the reasonable care in using it that should be given gages it will compare favorably with hardened steel for durability.

Of course the cast-iron gages will not prove satisfactory if they are subjected to the outrageous treatment which some so-called tradesmen are in the habit of giving them. For example, I have seen journeymen fix a lathe carrier to the handle of a plug gage, and attempt to screw the gage through the hole they were gaging. Sometimes the gage would get stuck when halfway in the hole, and it would easily stick if the work was a spongy casting. Then they would either slip a piece of tubing over the tail of the carrier, and try to start the gage out by pulling on the tubing, or else the work had to be taken from the chuck and the gage driven out.

A good way to case-harden cast iron is to heat the casting to be cased to a cherry red, and dip it in the following solution: 1 pint oil of vitriol, 2 pecks of salt, 4 pounds alum, ½ pound yellow prussiate of potash, ½ pound cyanide of potash, 1 pound saltpeter, 20 gallons of water. Repeat the process twice if the casting is not hard enough the first trial.

Master Plates and Their Uses in Die Making*

The Intricate Dies Used by the Veeder Manufacturing Company in Making Accurate Castings Are All Produced with Master Plates

BY E. H. CROSBY†

A master plate, as readers of the AMERICAN MACHINIST are aware, is a metal plate containing a number of holes having the position of their centers to correspond with centers that have to be accurately located in a piece of work. The master plate is always fastened to the lathe face plate with clamps, but the work may be fastened to the master plate with clamps or with screws by having the screws pass through the work and into the master plate. Or, very often, the work is soldered to the master plate, but soldering is only resorted to when it is not convenient to use clamps or screws. Soldering is dangerous for the reason that shrinkage of the solder on the side of the work is quite likely to draw the work sidewise, and thus the accurate location of the work with relation to the holes in the master plate is lost. Master plates are generally made of steel, though occasionally for hurry-up jobs they are made of brass; if they are to be used indefinitely and for accurate work, they should be made of steel.

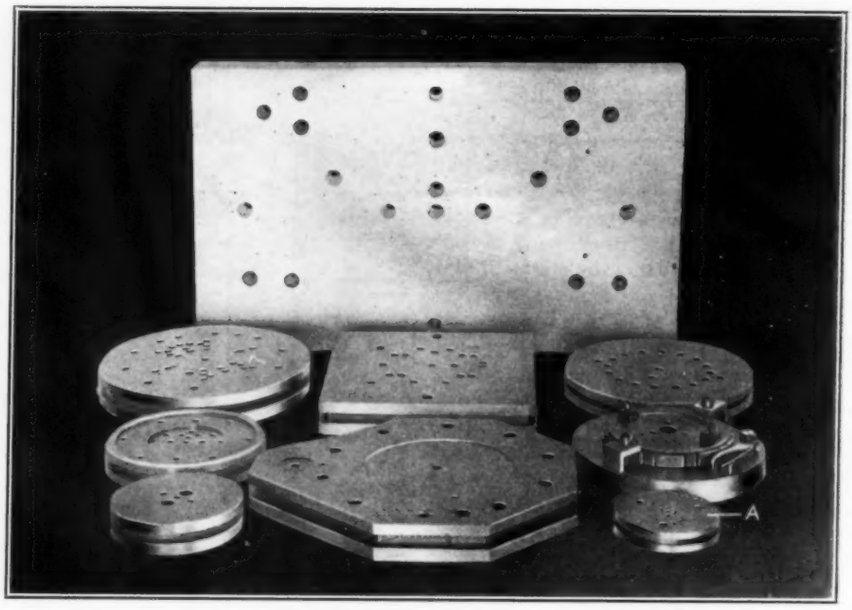

FIG. 1. GROUP OF MASTER PLATES FOR DIE WORK

The accompanying half-tones and sketches are illustrations of actual shop practice at the works of the Veeder Manufacturing Company, Hartford, Conn., who are specialists in the manufacture of accurate machine-made castings which are made in steel dies operated by automatic machines. The use of master plates is invaluable in the construction of these dies and they constitute the only practical way to obtain good results when extreme accuracy is required.

A TYPICAL PLATE

In order to describe some of the methods used for producing master plates let us take as an example plate *A*, Fig. 1. This plate is made from machinery steel which with careful use gives a hole having a surface sufficiently hard to eliminate the necessity of hardened bushings. The plate is carefully ground to bring its two sides perfectly parallel. The sides of the grooves in the periphery are intended for

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†Superintendent, Veeder Manufacturing Company.

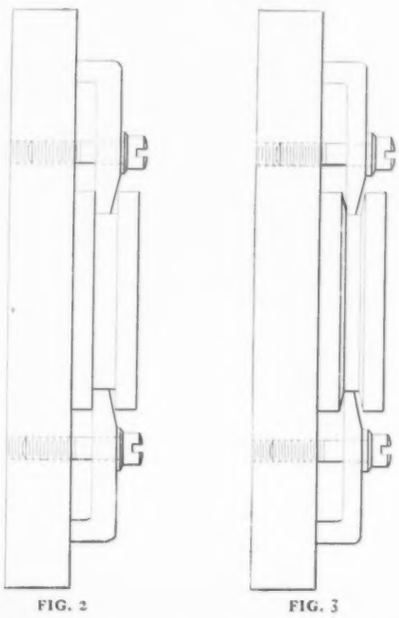


FIG. 2 FIG. 3

RIGHT AND WRONG WAY TO HOLD A MASTER PLATE

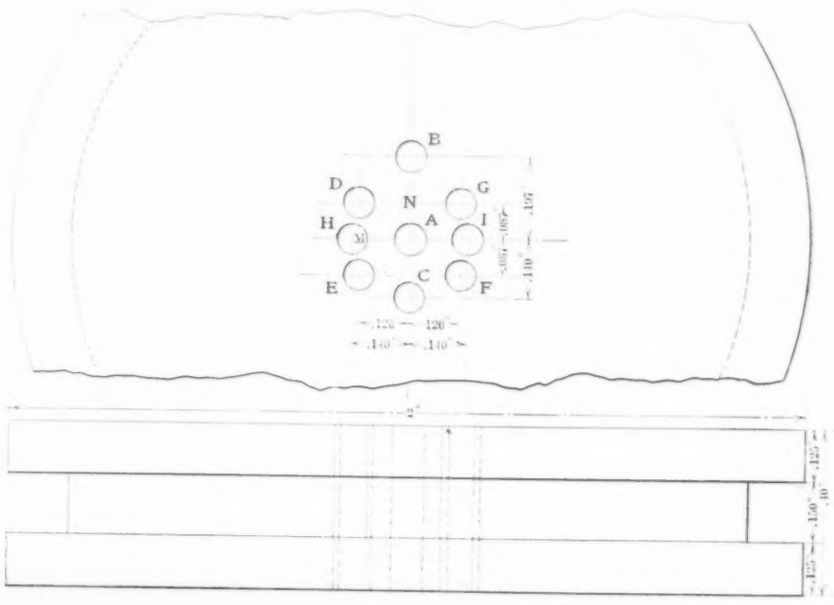


FIG. 4. CIRCULAR MASTER PLATE

clamping surfaces, and must be perfectly parallel with the outside surfaces of the plate as illustrated diagrammatically in Figs. 2 and 3. The correct way is shown in Fig. 2 and the incorrect way in Fig. 3. If not made as shown in Fig. 2 there will be trouble when attempting to move the master plate slightly sidewise for the purpose of truing a button or plug perfectly concentric with the axis of the lathe. It can readily be seen that there will be difficulty in controlling the sidewise movement when the piece is held on the face plate with three or four clamps which rest on an angular surface as in Fig. 3.

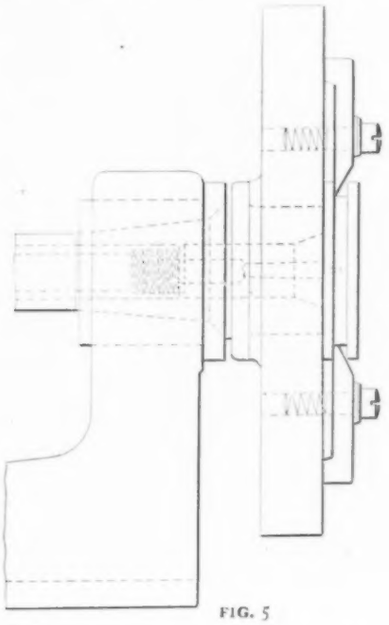


FIG. 5

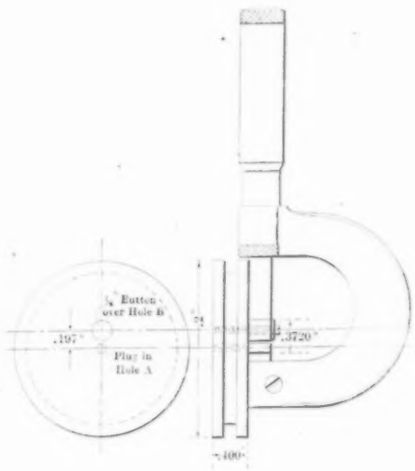


FIG. 6

SETTING THE MASTER PLATE AND LOCATING BUTTON

Locating and Boring Holes

In locating the holes *A*, *B*, *C*, *D*, *E*, *F*, *G*, *H* and *I*, which have a common diameter of 0.070 inch as shown in Fig. 4, we begin with center hole *A* by placing the master plate on the lathe face plate perfectly concentric with the axis of the spindle. We then drill a hole about 0.005 inch smaller than the finished size. It is then bored to within about 0.0002 of its correct diameter, then reamed, the reamer really acting as a burnisher rather than a cutting tool. This hole, together with the others, is first drilled and bored through one side of the plate. After placing all the holes in one side it is then reversed and each hole in turn placed on the center plug as in Fig. 5 and the hole bored to meet the hole on the plug. This method is used for boring the holes through the plate as they are likely to run and the inner ends of the holes be slightly out of true when they are carried all the way through the plate from one side.

The Button, Plug and Micrometer

The center of hole *B*, Fig. 4, is located approximately 0.197 inch from *A* with a pair of dividers, and is then drilled and tapped for a 1/16-inch screw. In *A* we place a hardened and ground plug as shown in Fig. 6. With the tapped hole at the approximate center for *B* we clamp a hardened and ground button, then measure for center distance *A B* as in Fig. 6. The center plug in *A* which is 0.070 inch diameter and the outside end of which is used for measuring over, must be ground perfectly parallel to its axis and with the diameter exact. The button clamped at *B* must also be hardened and ground parallel to its axis and its ends must be perpendicular to the axis. The button is moved slightly by striking very gently on the side until the micrometer measurement is 0.3720 inch. Half the diameter of the button, 0.125 inch + half the diameter of the end of the plug, which is 0.050 inch = 0.175 inch. 0.3720 inch − 0.1750 = 0.197 inch, which is the distance between *A* and *B*.

We then mount the master plate on the bench-lathe face plate and indicate the button as in Fig. 7. After the button is carefully centered with the indicator, it is removed and hole *B*, Fig. 4, bored and reamed like *A*. The same method is used for locating *C* with the exception that *A*, *B* and *C* have to be in perfect alinement. With plugs in *A* and *B* and a button at *C*, all being of equal diameter, we obtain the alinement with a thin, straight edge as in Fig. 8. After indicating the button at *C*, it is removed and hole *C* bored and reamed as were *A* and *B*.

Finding Center Distances

Before locating hole *D* we have to find the center distances *B D* and *A D*. The center line through *D G* being perpendicular to the center line through *B A C*, *B N D* forms a right-angle triangle.

$$\sqrt{BN^2 + ND^2} = 0.16726$$

inch or distance *B D*.

$$\sqrt{AM^2 + MD^2} = 0.15312$$

inch or distance *A D*, or radii *A D*, *A E*, *A F* and *A G*. By using a button at *D* and plugs in *A* and *B*, we proceed to locate and bore hole *D* in the same manner as we did with either *A*, *B* or *C*.

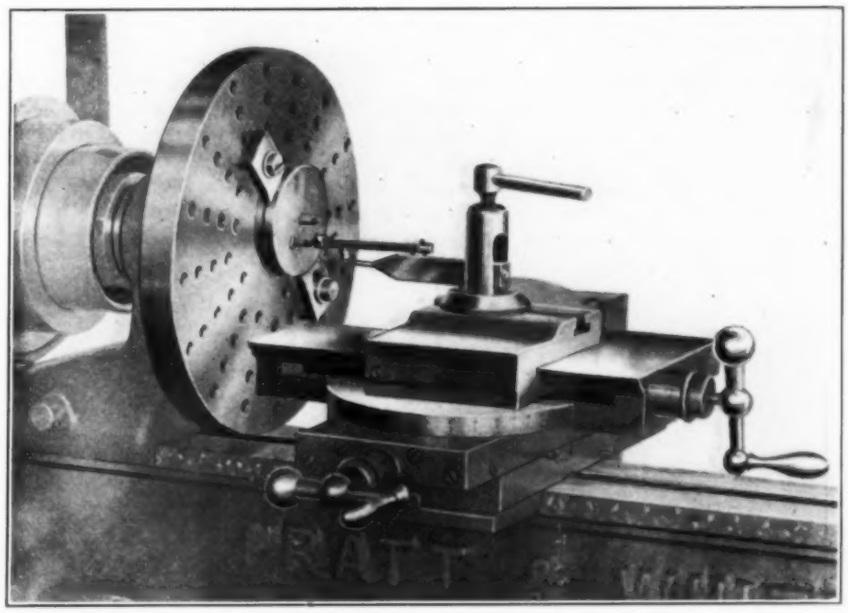


FIG. 7. INDICATING A BUTTON ON THE MASTER PLATE

By placing a plug in *D* together with the use of a special button as shown in Fig. 9 we will locate hole *E*. Plug *Y* in the center of the special button is made to fit perfectly in hole *A* in the master plate. The distance between centers *O P* in Fig. 9 equals radii *A D*, *A E*, *A F* and *A G*, Fig. 4. Plug *Y*, Fig. 9, is placed in hole *A* and the button set against a plug

0.17176 inch diameter in D; the radius of the plug in D is 0.08588 inch, which, added to 0.08812 inch, the radius of the special button, $=0.1740$ inch or the distance DE. The special button is held against the plug in D by a small spring and clamped firmly against the surface of the master plate with a screw as shown in Fig. 9.

Indicating, Boring and Lapping

We then clamp the master plate on the lathe face plate. The special button being longer than the plug in D as shown in Fig. 9 enables us to locate E by indicating as in Fig. 7. The master plate being securely clamped to the lathe face plate, then the special button, Fig. 9, is removed by putting a screwdriver through the lathe spindle from the back end and removing the screw from plug Y. On the head of this screw will be noticed a cupped washer which guides the point of the screwdriver into the screw slot. After taking out the screw, the special button is removed and we proceed to drill and bore hole E. Holes F and G are located in the same manner as E. Holes H and I can be located with a button by measuring from plugs in B, A and C, the same as we located D from A and B, but in this case we have three points to measure from, A, B and C. H and I can be located with a much greater degree of accuracy by using a special button as in locating E, F and G.

After all the holes are bored and reamed through the plate, they are all lapped just enough to make them of exactly the same diameter. The laps used are generally of brass or copper. The lapping operation is done by holding the master plate in one hand and working the lap with the fingers of the other.

Indexing Attachment and Micrometer Depth Gages

Fig. 10 illustrates a method used for laying out a master plate where extreme accuracy is not necessary. With the indexing attachment on the bench-lathe head we can get any division of the circle required. The milling attachment with its horizontal and vertical slides enables us to point off any radius required. The movement of the slides in either direction is measured by micrometer depth gages. The gage for measuring the movement of the vertical slide is clamped to an adjustable stop which is held to the knee of the milling attachment by a binding bolt in a T-slot. The depth gage for use on the horizontal slide is clamped to the bed of the lathe by means of a small angle iron. In the end of the spindle next to the face plate is a sharp point or center punch. After setting the point in any position required it is pressed into the surface of the master plate by the movement of the cross horizontal slide. In this way any number of holes can be located approximately correct to the required dimensions.

After the holes in the plate are all marked the prick-punch impressions are indicated with an ordinary indicator; but by using a special arbor with a fine-pointed male center at one end and a female center at the other, and placing the pointed center of the arbor in the prick-punch mark and the female center on the tailstock center, the prick-punch marks can be located with the fine indicator shown at A, Fig. 11. In indicating with the special arbor and fine indicator the point of the indicator is placed on the end of the arbor close to the master plate and upon rotating the work the indicator will

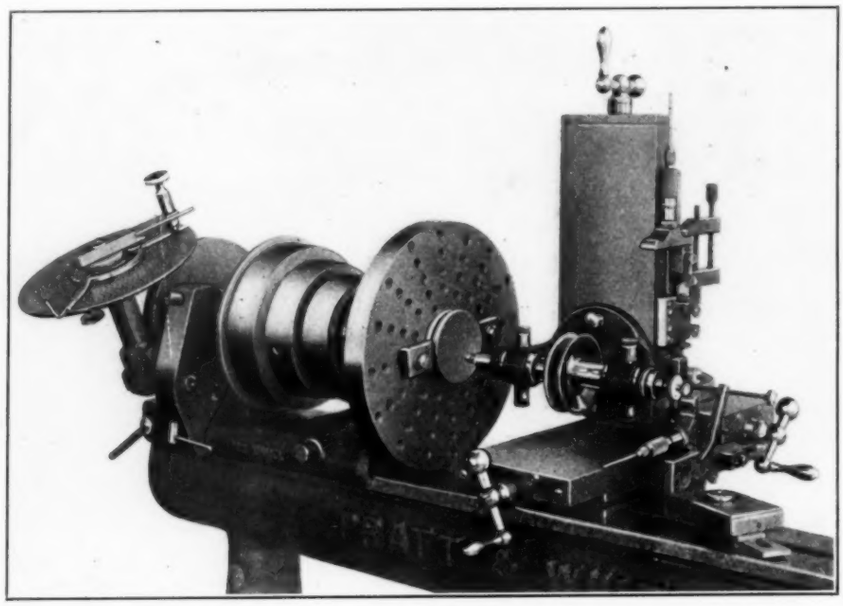


FIG. 10. LOCATING HOLES WITH THE MICROMETER DEPTH GAGE

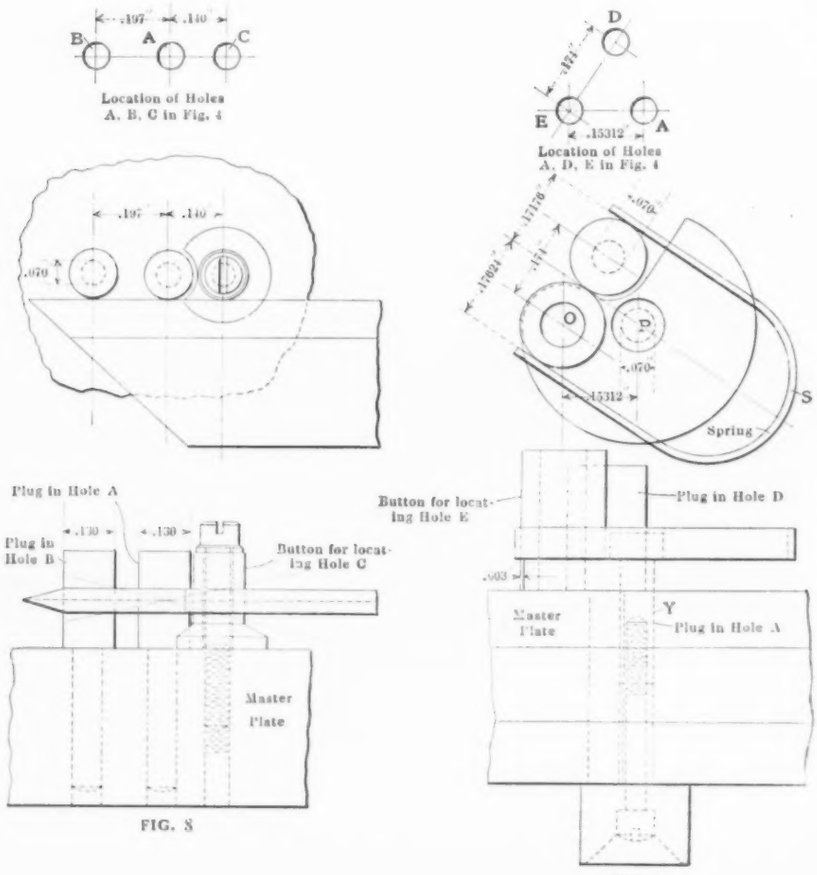


FIG. 8

FIG. 9

LOCATING INDICATOR BUTTON AND FINDING CENTER DISTANCES

show the amount the prick-punch marks are out of true. The holes are bored, reamed and lapped in the same way as for the master plate in Fig. 4.

Master-plate Recess and Bushings

Fig. 12 illustrates two points in particular to which it is desired to call attention. The bushing and recess indicated at *B* and *C* show two ways of locating two or more centers when they come within the diameter of a standard hole in the master plate. The recess *C*, which is made to fit the end of a centering plug, in most cases is practicable only for two centers; where three or more centers are necessary within so small a space the bushings should be used. The chief objection to the recess is on account of the necessary changing of the centering plug in the lathe spindle every time the plate is changed from a hole to the recess. If a center plug is once removed from the lathe spindle it cannot in general practice be placed back in the spindle true again, and if the work being done on the plate requires a perfectly true-running center plug it will be necessary to make a new one every time one is removed. With the use of the bushings this is not necessary as the holes in all the bushings can be the same diameter as the standard diameter of master-plate holes.

The master plate in Fig. 12 is equipped with three bushings. One of these, *D*, has the hole concentric, the other two, *B* and *E*, are eccentric. The large hole to receive the bushings is located by using a button as in the case of the master plate in Fig. 4. The bushing blanks are made a plug fit in the hole and keyways are cut in them as shown. A hole is carefully drilled and reamed from the edge of the master plate to the hole that is to be bushed and a pin fitted to this hole with its end passing into the keyway in the bushing blank, thus forming a key for the bushings. The bushing blanks are then set in place one after another and the hole for each bushing is located with a button.

An Accurate Grooving Operation

In Fig. 13 is shown a master plate made especially for putting the grooves in hemispherical piece *F*. This master plate is a T-shaped casting to be clamped to the lathe face plate by screws *G* and *H*. Plate *I* is held at right angles to the lathe face plate and centered and swiveled on the casting by a stud which is held in place by the nut *J*. In the bottom of plate *I* are 10 holes spaced to correspond with the spacing of the grooves required in piece *F*. Plate *I* can be indexed from one hole to another and held firmly in place by index pin *K*.

In mounting the work *F* on plate *I*, it is first fastened to a brass chucking piece, not shown. The chucking piece is held on *I* with screws and a dowel *L*. Plate *I* is then set in place on the T-iron and left just free enough on the stud to swivel. The center of the centering stud for *I* is in a direct line with the center of hole *M*. This hole fits a center plug in the lathe spindle; the T-iron being clamped to the face plate with screws *G* and *H*. The work is oscillated on the lathe spindle and the grooves milled concentric with the center of hole *M*.

If the piece *F* is to be hardened and ground the above operations are repeated for grinding as for milling. This has proved a very successful way of getting the grooves in piece *F* which has to be

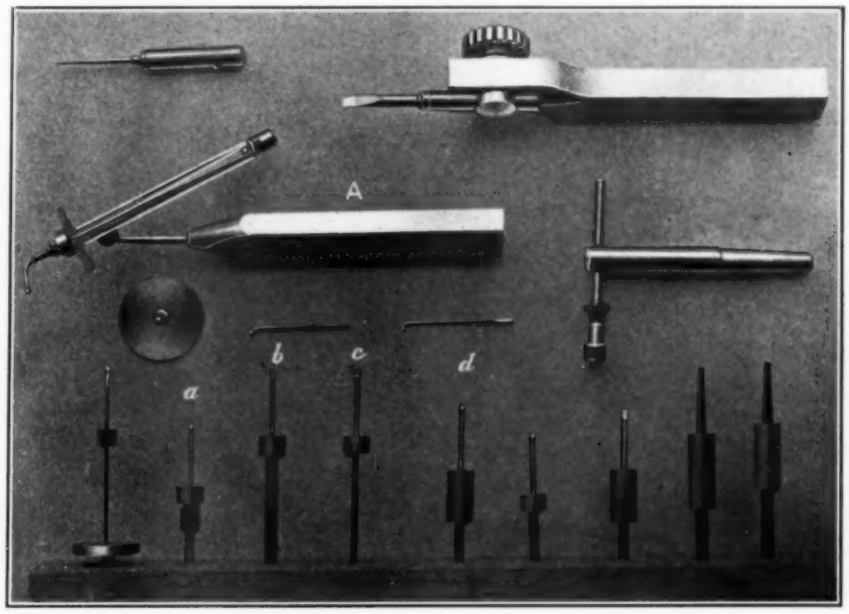


FIG. 11. TOOLS FOR BORING MASTER PLATES

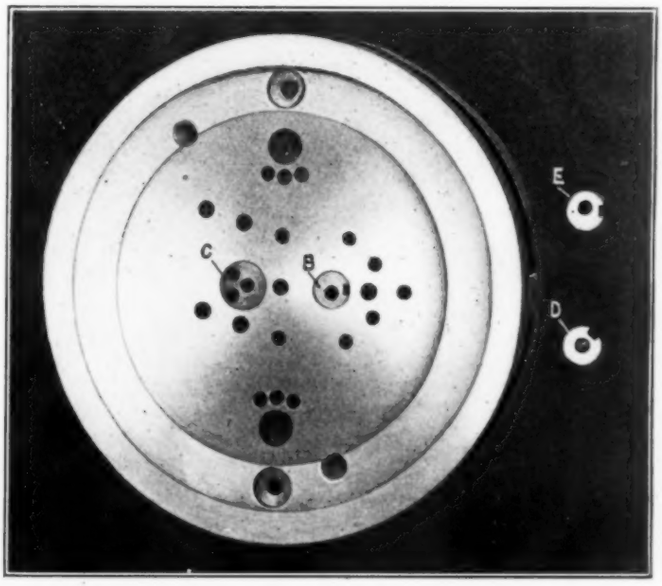


FIG. 12. A RECESSED AND BUSHED MASTER PLATE

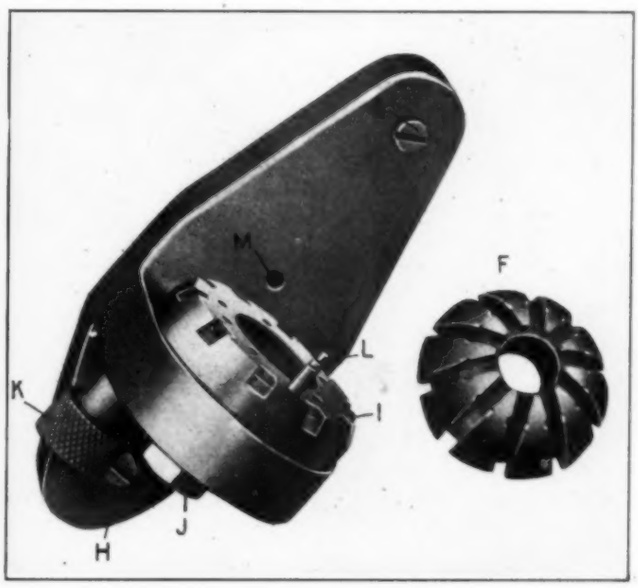


FIG. 13. A MASTER PLATE FOR A GROOVING OPERATION

very accurately spaced. A great advantage is that the piece can at any time be reproduced without difficulty.

Other Indexing Plates

Fig. 14 shows another form of master plate which is very useful. Plate *N* has one or more holes as may be necessary. These holes are located to accommodate the work, which is clamped on index plate *O*; the holes in plate *N* are used on the center plug in the lathe spindle. Index plate *O* is centered in plate *N* by a boss on the under side fitting into a recess in *N*. The work being fastened to the index plate, any hole in *N* can be transferred into the work any number of times or the holes spaced any number of degrees apart by the notches cut in the index plate *O*. The index plate is located by latch *P* and held in position by clamps *Q* and *R*.

The master plate in Fig. 15 forms quite an unusual combination. Plates *S* and *T* are of the same combination as Fig. 14, but have an additional movement on main plate *U*. The work is fastened to index plate *S*. This master plate was made for a very intricate piece of work and the illustration simply shows to what extent it is sometimes necessary to complicate such devices in order to accomplish the work in hand.

Boring Small, Deep Holes

Fig. 16 represents a boring operation on a piece of work mounted on the master plate, shown in Fig. 4. Here *A* is the master plate, and *B* is the mounting piece in which the work *C* is held. *B* is attached to the master plate with screws. In cases like this where holes of small diameter have to be carried to considerable depth, the holes are first drilled with a flat or twist drill leaving stock for boring. They are then bored for a short distance just large enough in diameter to receive the end of a hog-nose reamer. The reamer is then fed to the required depth of hole. Several reamers are seen at *a*, *b*, *c*, *d*, Fig. 11. This operation is repeated four times, removing with each reamer from the hole about 0.003 inch until the hole is the correct diameter.

This method works well in a deep hole of small diameter and is much quicker than using a pointed boring tool in the slide rest for the full depth of the hole, and with care the hole can be made as true as with the single-pointed boring tool. The collars, or rings, on the reamers in Fig. 11 are used for stops where holes are to be of a certain depth. These stops are simply steel or brass collars soldered to the reamer, and with the end faced off until the required distance from the point of the reamer to the stop collar is obtained.

Locating and Milling a Slot

Fig. 17 shows the method of milling a slot in a piece *D*. This slot which has to be perfectly radial to the hole *E*, will be seen at *F* behind the cutter, and is more clearly shown in Fig. 18 which illustrates the method of preparing the master plate *G* for holding the work *D* in correct position.

The two plugs *H* and *I* of equal diameter and held in the brass mounting piece *J*, Fig. 18, are placed in holes transferred from master plate *G*. Plug *H* is the correct center for hole *E* and plug *I* is in the correct position to bring the center of slot *F* in the proper relation to other holes

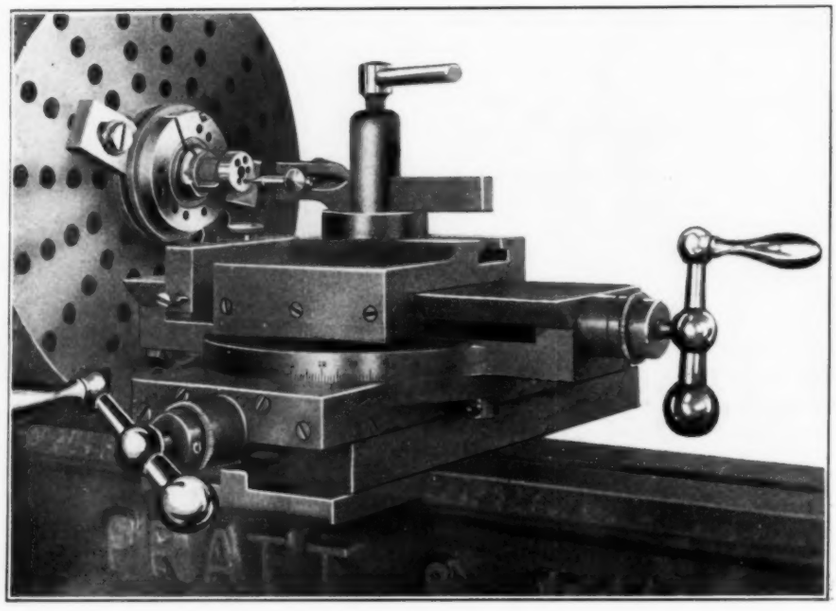


FIG. 16. BORING SMALL DEEP HOLES

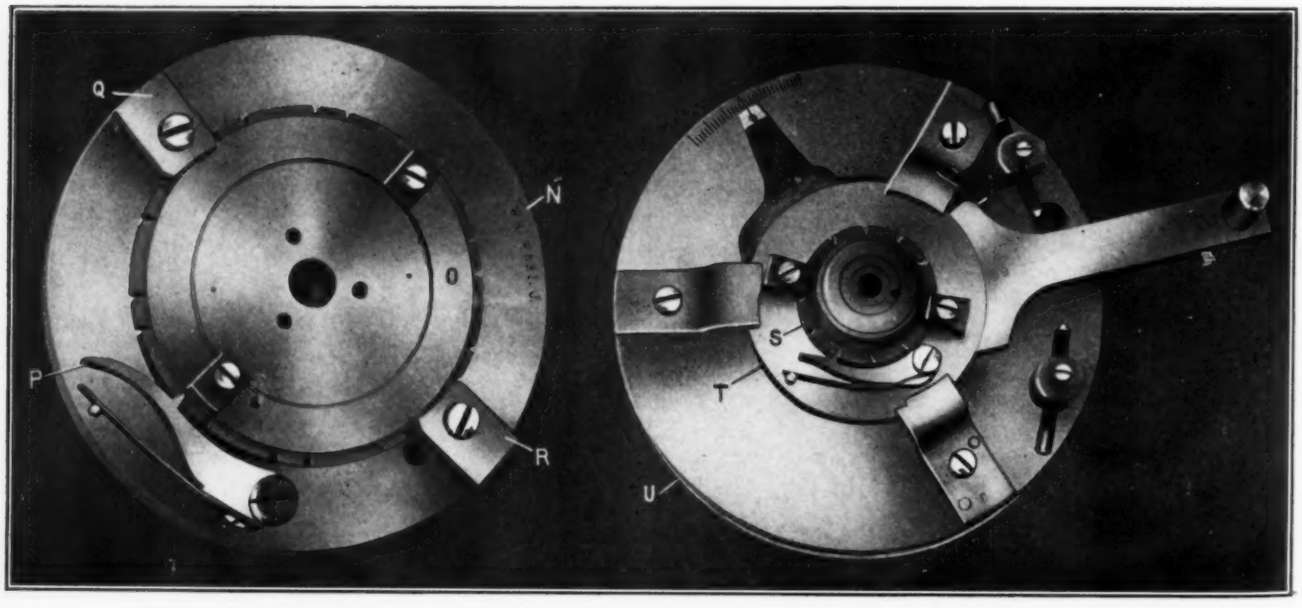


FIG. 14. AN INDEXING PLATE

FIG. 15. ANOTHER INDEXING PLATE

in the master plate. *I* is also the center for the outside of the piece of work. The master plate *G* is placed on a centering plug in the lathe spindle, at the center of plug *I*. The spindle of the lathe is then indexed until the indicator shows plugs *H* and *I* to be parallel to the movement of the horizontal slide. Mounting piece *J* contains a recess concentric with plug *I*, which was used for mounting the work *D* at the time the hole *E* was bored. Plugs *H* and *I* are removed and the work is again clamped in the recess which is concentric with *I*. Hole *E* is held concentric with the center of *H* by a special plug fitting *E* and the hole from which plug *H* is removed.

After clamping the work and placing a cutter in the spindle of the milling attachment we can proceed to mill the slot *F*, as in Fig. 17. The slot is first rough-milled and then to bring it central to the center line through plugs *H* and *I* we take a light cut on one side, then index through 180 degrees and take a cut on the other side without changing the setting of the cutter, and repeat this operation until the slot is the required width.

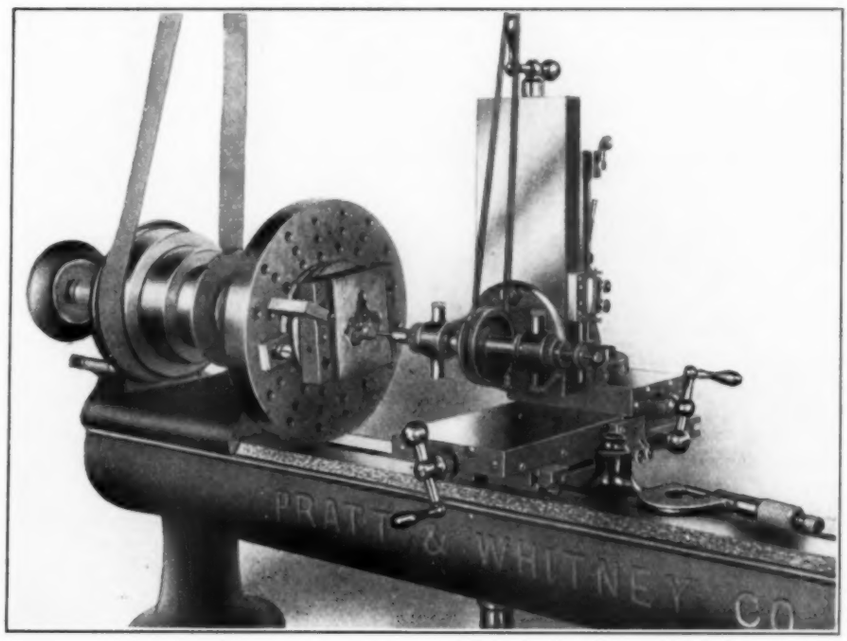


FIG. 19. MILLING OUT A DIE.

MILLING AND GRINDING OPERATIONS

Fig. 19 illustrates another interesting milling operation. The irregular shaped die or mold fastened to the face plate is worked out from holes in the master plate to which it is clamped.

Fig. 20 shows an operation of grinding four holes in a piece of work. The holes were transferred into the work before hardening, on the same master plate and after hardening it was remounted for grinding them to again match the master plate. The master plate is located on the face plate for each hole in the usual way by a centering plug in the lathe spindle. The lathe head and the slide rest holding the traverse spindle grinder are set high above the lathe bed on raising blocks so that the weights used for counter-balancing the work will clear the lathe bed. In the end of the traverse spindle is mounted a steel lap charged with diamond powder for grinding the holes.

DIE-MADE CASTINGS

Fig. 21 should be of interest as illustrating some of the castings produced by the Veeder Manufacturing Company's process for making small parts that would be difficult and very expensive to machine. This class of work is all made in dies produced by the aid of master plates as represented in this article. The casting at *A*, for example, is made in the die shown on the face plate in Fig. 19.

Material and supplies handled by the Isthmian Canal Commission for canal construction run into enormous figures. For the last fiscal year the department received thirty-seven full cargoes besides hundreds of part shipments. Among other items there were handled 23,300,000 feet of lumber, 254,000 cross-ties, 4000 piles and 50,000 tons of miscellaneous materials.

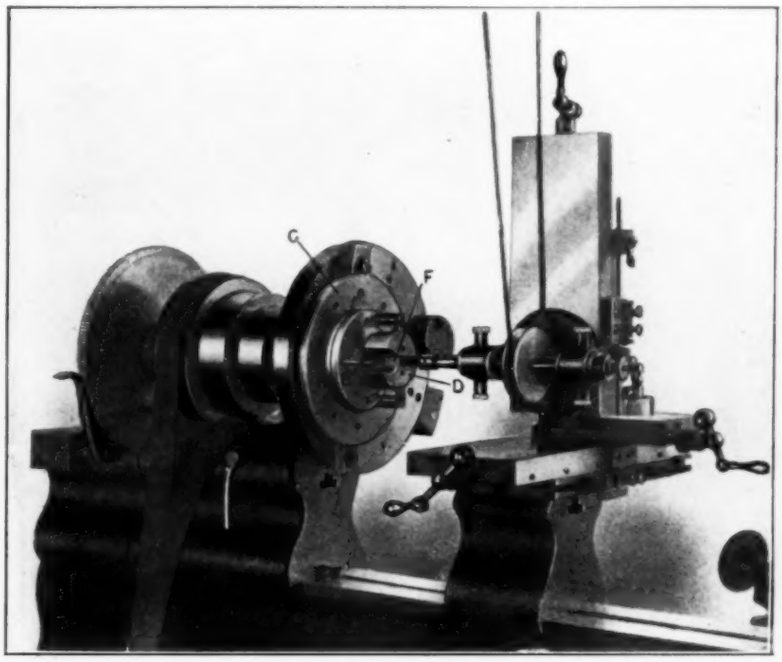


FIG. 17. A SLOT-MILLING OPERATION

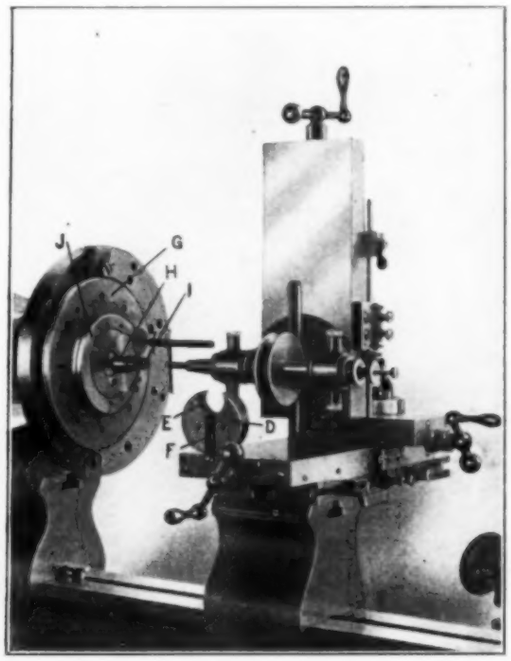


FIG. 18. PREPARING THE MASTER PLATE FOR THE OPERATION IN FIG. 17

The Most Frequent Cause of Boiler Explosions

By William H. Boehm*

If I were asked to state the most frequent cause of steam-boiler explosions† I would unhesitatingly say, *scale*.

That this is not generally known to boiler owners is a reasonable assumption, else inspectors would find scale in fewer boilers and boiler owners would exhibit greater interest when scale is found and reported to them. Many boiler owners, it is true, have learned that boiler waters usually contain more or less scale-forming matter. Some have learned that an accumulation of scale impairs the efficiency and increases the fuel consumption of a boiler. Some have learned even that an accumulation of scale allows an overheating of the boiler plates. But it usually takes an expensive object lesson in the way of a bag, or rupture, or explosion to make any deep impression as to the real danger of scale formation.

No boiler owner wants an object lesson of this sort. No boiler owner wants to jeopardize his own life and property and the life and property of others by fostering any condition that is dangerous. But just as certain as scale is allowed to accumulate to any considerable thickness in a boiler, just so certain is a bag or rupture of the boiler inevitable, unless perchance the scale happens to be of a spongy formation which is not often the case. Just why this is so is shown by the following simple experiments.

*Superintendent, steam, boiler and flywheel department, Fidelity and Casualty Company.

†By "Explosion" is here meant the tearing asunder of any part of a boiler by force of steam pressure.

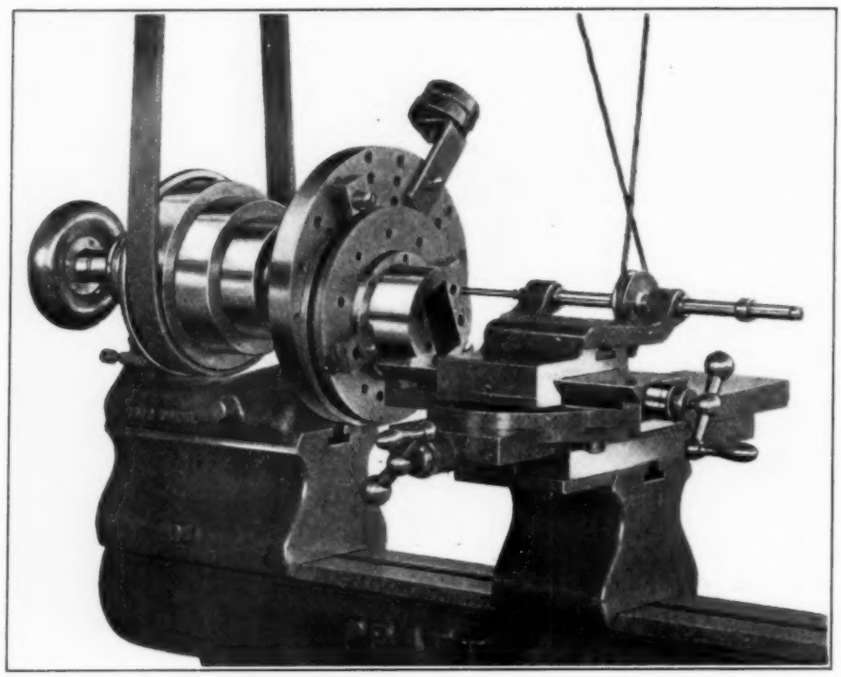


FIG. 20. A GRINDING OPERATION

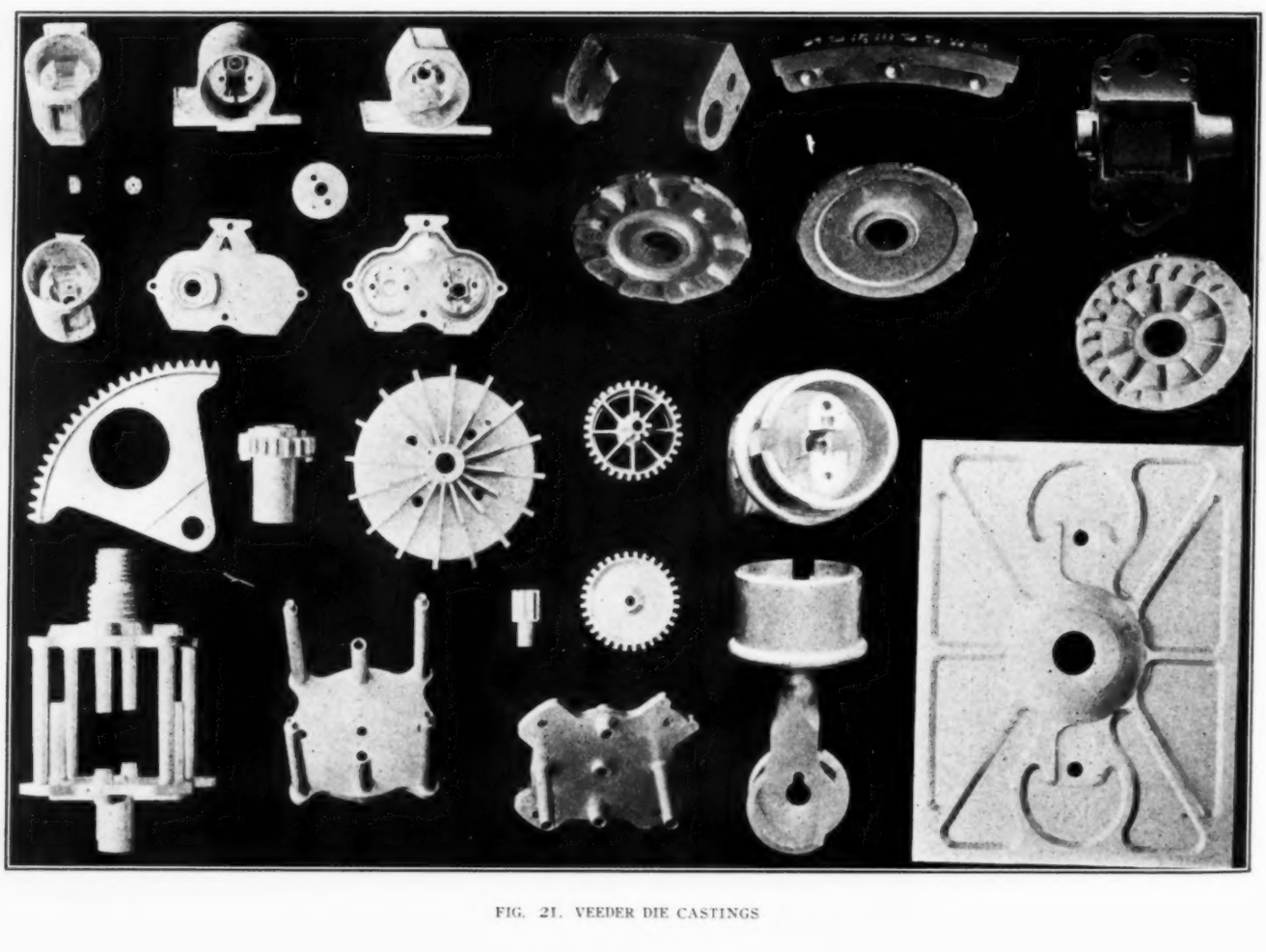


FIG. 21. VEEDER DIE CASTINGS

Take a piece of common writing paper and form out of it a pan or box by folding up the edges and fastening them at the corners with pins. Pour water into the paper pan thus formed, place it on a gas stove and turn the flame on full. If the pan be watched closely it will be found that so long as any water remains in it the paper will not burn; will not even char.

Take an ordinary granite-iron or tinned-iron stew pan and firmly glue to its under side a *postage stamp*. Pour water into the pan and place it on a gas stove so that the postage stamp will be in direct contact with the flame. Leave the pan on the stove until the water has boiled violently and then examine the stamp. The stamp will not even be charred, much less burned! In fact, it may be removed from the bottom of the pan and used to post a letter in the usual way. And this, notwithstanding the fact that it was on the under side of the pan and in direct contact with the hottest part of the flame.

Now, put into the pan a mixture of water and portland cement half an inch thick. This when set will be the equivalent of half an inch of scale. Repeat the experiment made before and it will be found that the stamp will burn up very quickly.

The reason that the postage stamp on the bottom of the vessel is not charred by the flame when no scale is present, is that the water being in immediate contact with the thin bottom of the vessel absorbs the heat as fast as it is put into the vessel by the flame. The result is that no matter how hot the flame may be the bottom of the vessel remains at practically the same temperature as the boiling water with which it is in contact. In an open vessel the temperature of boiling water, of course, is 212 degrees and this is not sufficiently high to char paper. When scale is present the water cannot absorb the heat as fast as it is put into the vessel by the flame, as a result the temperature becomes greater than 212 degrees and burns the postage stamp.

It is the same with steam boilers.

If the water comes in direct contact with the thin plates, the heat is absorbed, the temperature of the plates remains practically the same as the water, and no harm is done. If there be a considerable thickness of impervious scale in the boiler, the water cannot absorb the heat as fast as it is put into the plates by the furnace, as a result the plates become overheated, get red, become plastic and finally give way to the force of steam pressure, causing a bag, or a rupture, or a violent explosion of the boiler.

Scale endangers the safety of boilers in other ways. It clogs the feed pipes, preventing the feed water from entering the boiler freely. It clogs the connections to the steam gage, causing it to read incorrectly. It clogs the connection to the water gage, causing it to indicate ample water when none at all is in the boiler. Pieces of it get under valves and prevent their closure. A blow-off valve, for instance, screwed down hard and thought to be shut, recently allowed all the water to leak out of a boiler and caused its burning into a mass of warped plates and bent tubes fit only for junk.

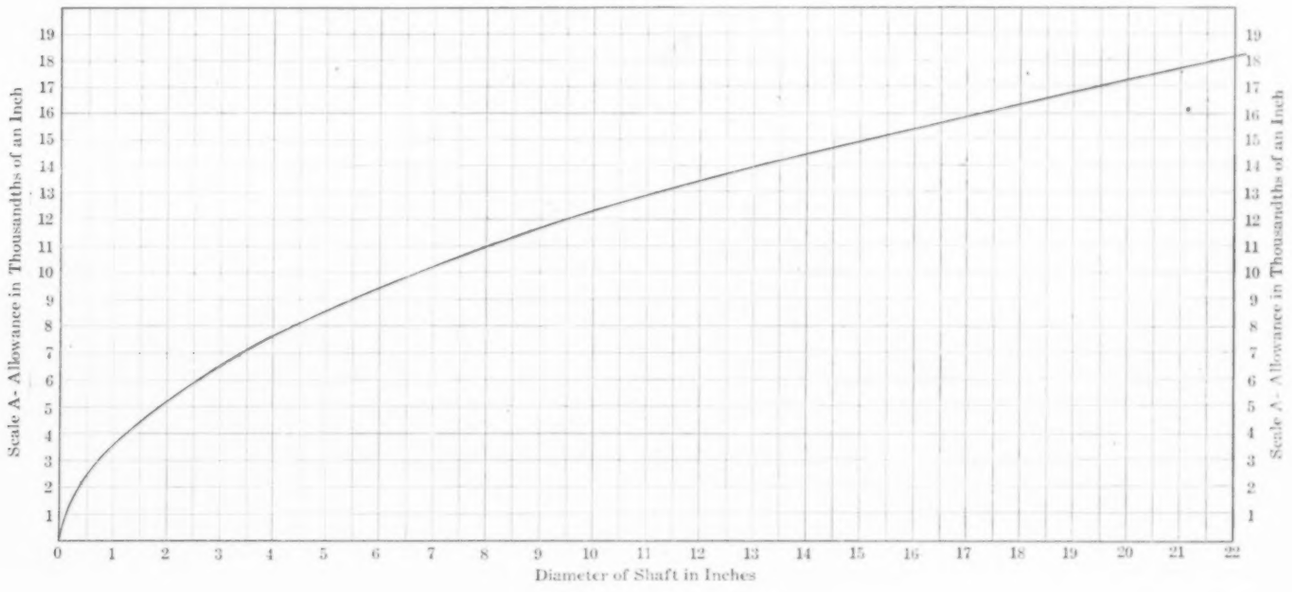
Scale in boilers, therefore, is a serious matter.

In order to prevent its accumulation it is good practice to eliminate the scale-forming matter from the feed water before allowing it to enter the boiler. This can be accomplished either mechanically by means of separators or chemically by treating the water in vats especially arranged for the purpose. If preferred, compound may be fed with the water into the boiler, but in such case the water should be analyzed and the proper compound prescribed by a chemist making a specialty of such matters. Kerosene oil fed into the boiler has proven beneficial in many instances. Zinc plates attached to the boiler so as to make intimate electrical contact have been used also with varying degrees of success. But, whatever remedy is used scale should never be allowed to accumulate in boilers; and all boilers should be opened frequently enough to make certain either that none is there or to remove any that might have accumulated.

A Chart for Forcing Fits

By O. James

The accompanying curve gives the amount in thousandths of an inch that a shaft must be larger than the hole for a force fit. The numbers on the vertical scale *A* represent this amount in thousandths.



ALLOWANCES FOR FORCING FITS

An example will best serve to explain its use. How much larger than a hole 10 inches in diameter should a shaft be turned for a force fit? Enter the horizontal scale at the ordinate marked 10 and run up vertically to the curve, then over horizontally to the vertical scale *A*. The nearest number to the intersection of the vertical scale is 12; then the shaft should be turned to 10.012 inches in diameter.

Machinery consumption in Japan during the first three months of this year shows a decided increase over the corresponding period of 1907. The imports ran to $5,126,199 against $2,543,470 in 1907 and if the remainder of the year shows continued activity 1908 will be a banner year in Japan's machinery opportunities.

A New English Gear-cutting Machine

Rack Tooth Shaped Cutters Are Used in Reciprocating Gangs—The Work Is Rotated and Moved up and down past the Cutters

BY I. W. CHUBB

A new type of gear-cutting machine in which, in the small size, the work is caused to reciprocate in front of the cutting tools, while in the larger sizes the reverse action occurs, has been patented by Spencer & Spiers, Huddersfield, England. The smaller size is illustrated in Figs. 1, 2 and 3, while the first design of the machine is shown in vertical section and plan by Fig. 4. The drive is by means of cone pulley and back gearing to a crankshaft. This gives adjustable motion by a ball-ended connecting rod to a plunger carrying on its upper end the blank to be cut. Simultaneously the job is slowly turned, the lower worm and worm wheel illustrated in the vertical section producing this motion. Above it will be seen a second worm and worm wheel, the latter driving the top racks for the tool slides. As the tool is actually in existence, however, an alteration has been effected. The racks have been taken off and the tool slides, Fig. 5, are driven by screws connected for simultaneous movement by bevel gearing. The motion is more regular.

The nature of the tool is plain from the plan in Fig. 4. The cutters have sides and faces of the contour of a rack the form of which is the base of the system of gears to be cut. The object has been to produce a gear-generating machine in which only one set of cutters is needed for each pitch, irrespective of the number of teeth to be cut in the gear. In the machine illustrated in Figs. 1 to 3, the stroke of the work spindle is 6 inches and blanks 4 inches face by 16 inches in

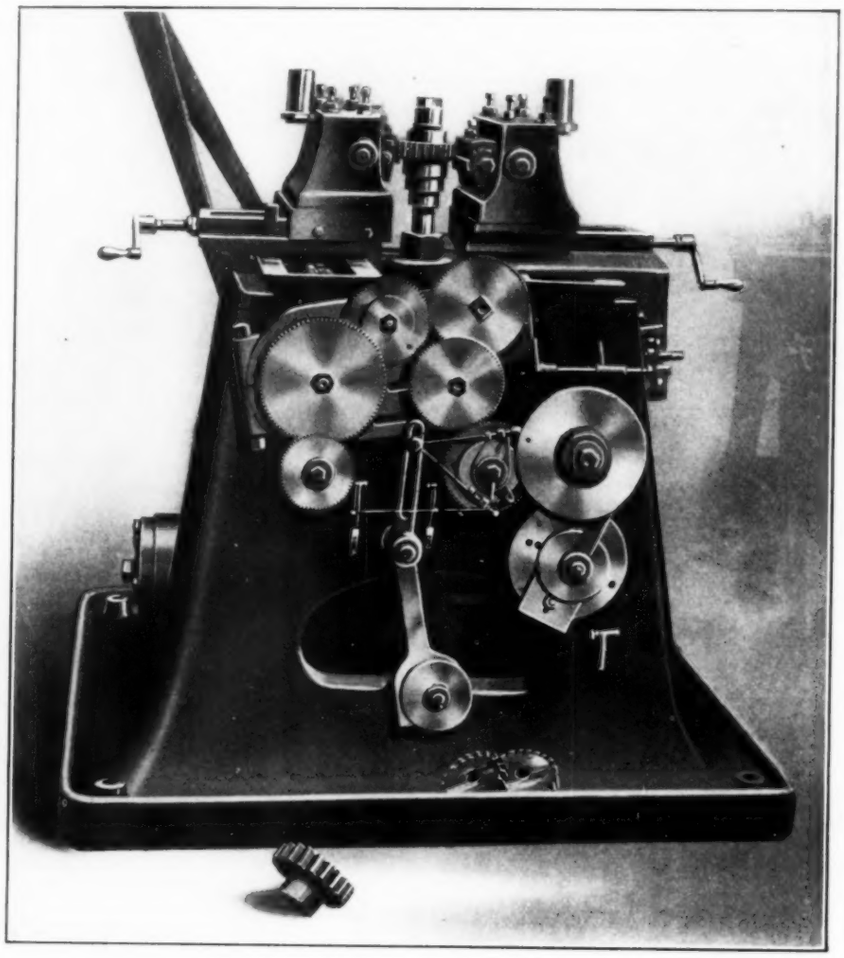
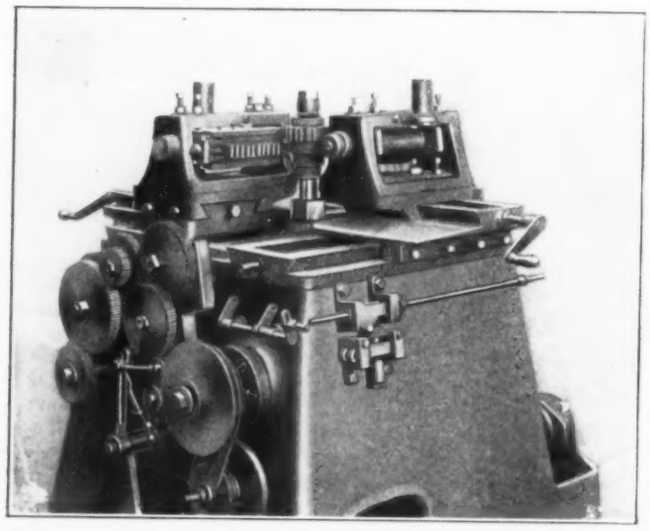


FIG. 3. END VIEW OF NEW GEAR-CUTTING MACHINE



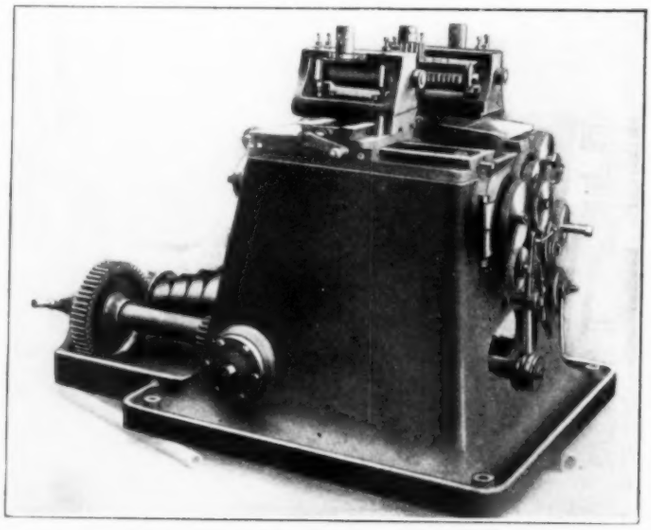


FIG. 1 FRONT AND BACK VIEWS OF NEW GEAR-CUTTING MACHINE FIG. 2

diameter can be cut. The cross movement of the tool slides is 8 inches and the longitudinal movement 14 inches. The machine will cut up to ¾-inch circular pitch, and recently produced a 20-toothed gear, ⅝ inch pitch and 1¼ inches wide in cast iron in 28 minutes. The cutting speed was about 60 feet a minute. The tool holder is shown in Fig. 6. It will take twelve cutters of ⅝-inch pitch. The slides have been rearranged (to be more rigid on the upward cutting stroke) as seen in Fig. 7, which shows them turned up at right angles. With this form of slide the times taken will, it is expected, be halved. To prevent breakage to the

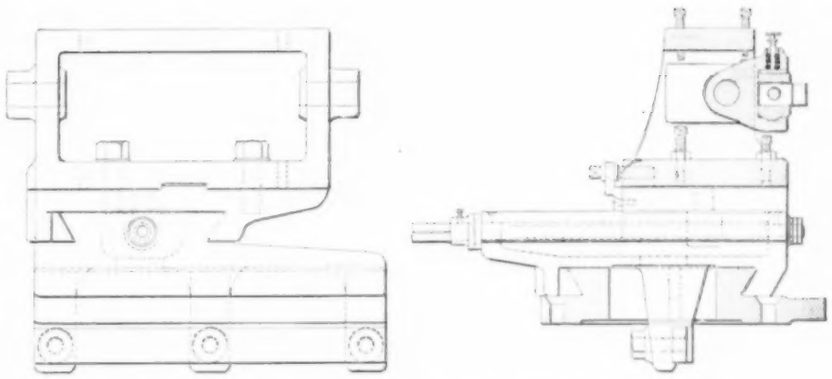


FIG. 5. ARRANGEMENT OF TOOL SLIDES FOR NEW GEAR-CUTTING MACHINE

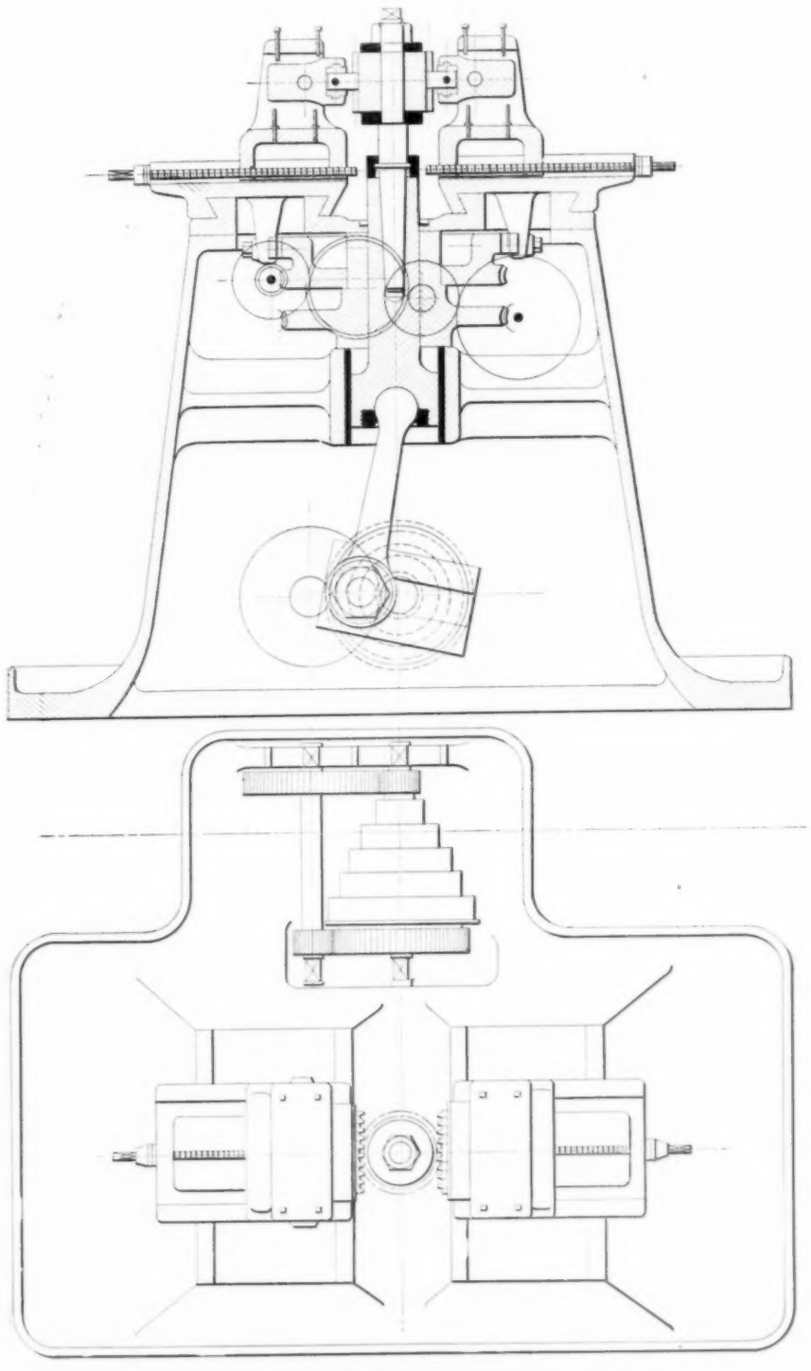


FIG. 4. VERTICAL SECTION AND PLAN OF NEW GEAR-CUTTING MACHINE

edges, due to the jump of the blank when it leaves the cut, the driving shaft is cranked and connected to a dashpot so that when the cut is finishing the maximum compression occurs. In the new design the tool holders will be controlled pneumatically from a dashpot so that the tools may present proper cutting and clearing edges both on up and down strokes.

So far no steadying device has been found necessary for the top of the work spindle; the two tools on the opposite side of the work prevent any tendency to tilt. The worm wheel driving the dividing wheel proper, which, of course, rotates the work, is connected by a train of change gears (seen in the end view) to the screws for the slides. A ratchet motion of an ordinary type provides from the main shaft the intermittent motion thus required. A trip motion is also provided, as may be seen, but this again is of ordinary design.

The form of cutters, a finished gear and an unfinished gear showing the method of tooth development will be seen in Fig. 8. It will be noticed that the first tooth space is almost completed before the cutters enter the second space.

A machine intended for larger blanks is illustrated in Fig. 9. Here again two cutter carriages are used, placed at opposite sides of the machine. The carriages are arranged to cut both on the backward and on the forward stroke of each carriage. Worm gearing, controlled by the worm shaft by which the blank is rotated, is used to feed the cutters past the blank at the right speed. Also a differential gear is provided so that further rotation may be given to the blank, and parts that are uncut when the cutters have gone by in one direction can be brought into position to suit the cutters on the return stroke. The differential gear is controlled from one of the cutter carriages. Here, however, the sets of cutters are reciprocated by a crank-disk motion. One set of cutters moves in the opposite direction to the other set and thus a couple is formed which tends to rotate the blank in the right direction and at the right speed. It will be seen that as each cutting stress is opposed by a practically equal stress in

an opposite direction, such stresses will be taken by the machine itself, and will not tend to displace the blank or throw it out of truth during the process of cutting. A further claim is that the cutters, being straight-sided, can be more cheaply and accurately produced than either the hob or circular-milling cutter. Thus, although it is very difficult to grind correctly the contour of a gear-milling cutter or hob after hardening, the cutters in this machine lend themselves specially to this operation and could probably be finished more cheaply by grinding than by any other method.

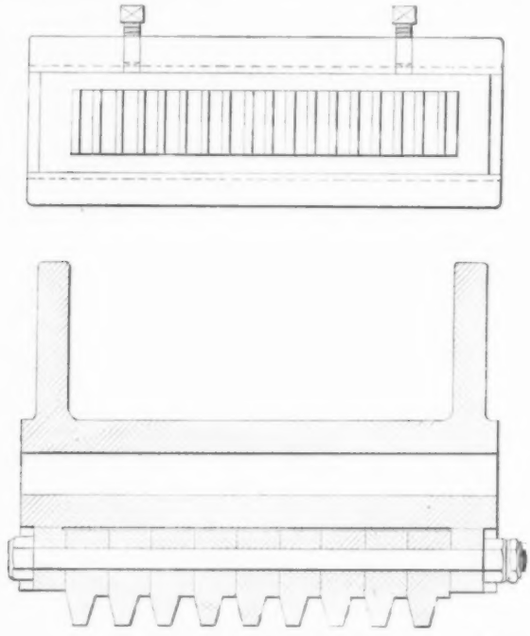


FIG. 6. DETAILS OF GEAR-CUTTING TOOLS AND HOLDER

The Art of Selling

BY ENTROPY

Recent statements of a popular American paper regarding unsuccessful attempts of American salesmen to introduce their methods in England, and the attention which they have had from English papers, lead us to consider whether or not the American public will always stand for the treatment that it has long been used to. Salesmanship in this country has too often meant mere brag and bunko, and too seldom a knowledge of what was to be sold.

I recall a chap who dropped into the office not long ago selling asphaltum paint. A little inquiry brought out the information that his house knew the business from A to Z and that their competitors did not know even the A part. He was ready to sell us asphaltum paint for anything from the smokestack to the office floor. Finally he very obligingly went away with an order for a barrel of *white asphaltum*. I have not seen him since, nor have I seen the paint.

On another day the proprietor and I were in the office during the noon hour. We had just been having some alterations made and I may possibly have gotten a little dirt on my person in following out my unquenchable desire to help things along. The door opened and one of the AMERICAN MACHINIST'S most esteemed advertisers blew in. He sized up the situation at a glance, as all well regulated Western business men do, and then asked me, "When will someone be in?" I assured him that he "could search me," or words to that effect. He blew out again. Now these are samples of what is to be expected, and every reader knows that he may reasonably expect to run across any

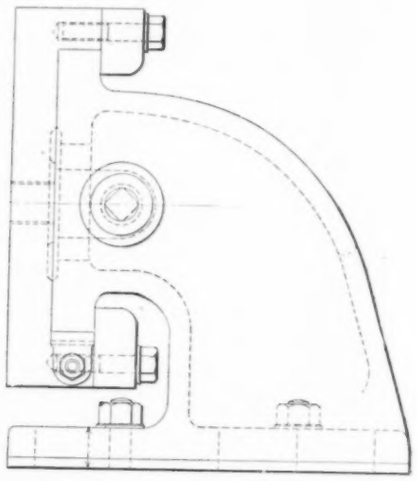
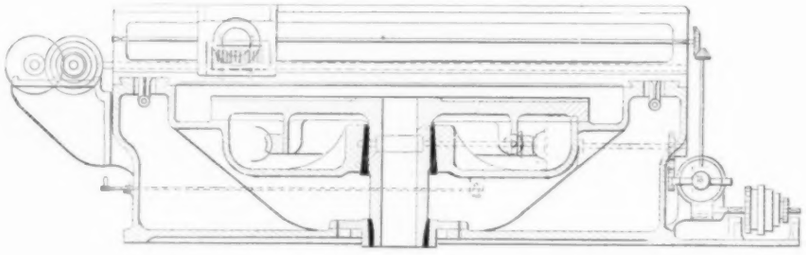


FIG. 7. REVISED DESIGN FOR TOOL SLIDE



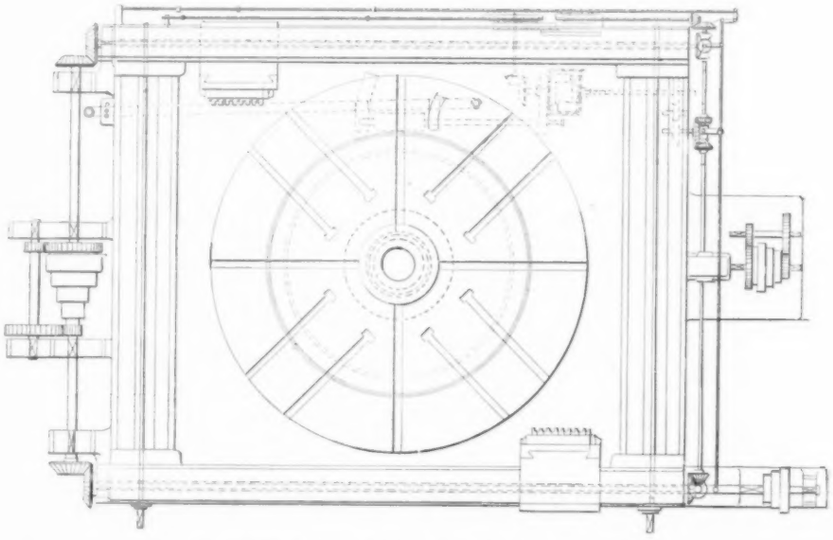


FIG. 9. GENERAL DESIGN OF A LARGE GEAR-CUTTING MACHINE USING THE SAME PRINCIPLE

day just as gross exhibitions of ignorance and discourtesy. But it is a fact that the business man has learned a great deal from traveling men; sometimes because the traveling man had something new to tell, sometimes because the business man was in a business for which he had no training.

When I was mechanical superintendent of this same concern to which I have referred, I had my office so located that you had to go up a flight of stairs, through another office, across a bridge into another building, out through one shop, around a right-angled turn into another shop and there it was next to the buzz-saw in the pattern shop. If a man finally got that far I was pretty sure he wanted to see me badly enough so that I wanted to see him. If he proved too long winded a touch of my foot would jar open the door on the side toward the buzz-saw; then he would be drowned in noise and beat a retreat. I always regretted having to give up that office.

I believe the time is drawing near when salesmen will of necessity be engineers, and when the gentle art of hypnotizing a man into buying something that he does not want, does not need and that he will regret having bought before the agent is outside the door, will fall into disuse. Persistence has its place; patience is a necessity to the man who would land a customer, but mere brag and rush and cheek cannot take the place of gentlemanly persistence backed up by a thorough knowledge of what one is selling.

I would not wish to go to the extreme that I heard stated only the other day. Said one man, "Personal influence on the part of a salesman is nothing, it is all a question of merit. Goods are sold today on the basis of scientific test, not on some irresponsible salesman's say-so." I do not believe there ever was a time when more depended on a salesman's persuasive ability and his ability to command confidence in himself. Few business men really know all the details of their business. They depend on the men under them for judgments, and knowing that they are depending on other men they watch their men closely and are quick to discern who is talking facts and who is falsifying. The salesman's contest is with the foreman whom the proprietor calls in consultation and whom very often the salesman does not see. It is a contest for the proprietor's confidence; that is a question of personal favor more than of any merit of the goods.

The man who has made the greatest impression on me as a salesman is a machine-tool man. He is a machinist by trade and knows pretty well what can be done and what is done on the tools he sells; but his strong hold is his personality. He does not try to rush off his customer to the nearest bar room, nor does he invite him out to "see the town." He just sits down with a customer to study his needs and incidentally the man himself. When he thinks the psychological moment is at hand he pulls out his order book and begins to write the order; then the other fellow signs it. It looks so easy that it seems a shame to let him do it and I have several times felt like stepping in and asking his customer if he was really awake. Of course, the customer thinks he is awake but he is really hypnotized. I know, for I have written one or two orders myself. The one redeeming feature in this case is that this particular man wants to keep one region for himself; he does not sell anything that he does not think the purchaser will want when he wakes up.

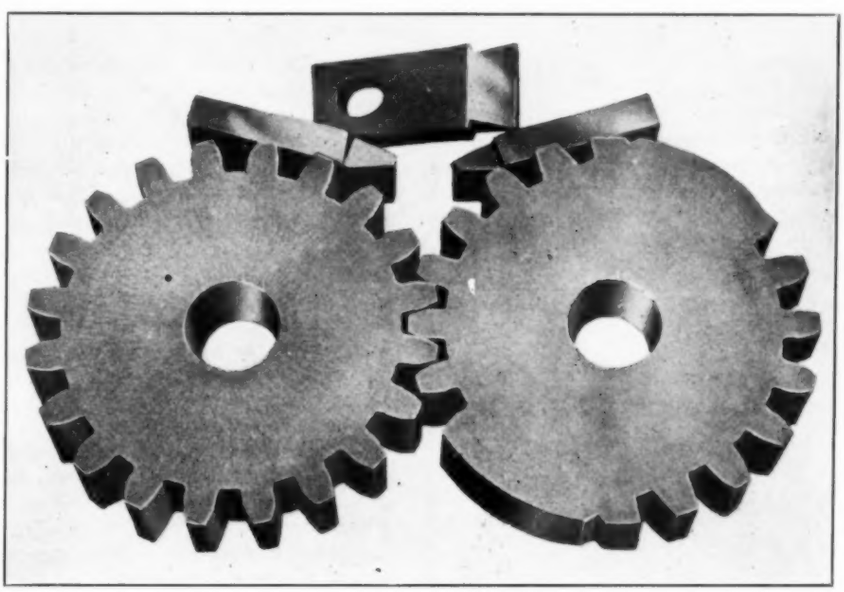


FIG. 8. TOOLS, A FINISHED AND PARTLY FINISHED GEAR FROM NEW GEAR-CUTTING MACHINE

Welding a Shaft That Would Not Weld

BY E. C. OLIVER

One afternoon a shaft came into the shop from a sawmill. It was 3 7/16 inches in diameter and had broken in a bearing near one end. It was to be welded and replaced in time to start the mill the next morning. The usual preparations were made, a fire built in the big forge, a ram suspended, etc. The shaft was heated, the end trimmed and upset,

THE WAY THE SHAFT WAS PREPARED

a piece of new shafting was similarly prepared and a jump weld made; that is the motions were properly gone through but the weld did not occur.

This was particularly exasperating because our blacksmith had sufficient assistance and advice to weld several shafts. There were the shop boss and the millwright to give helpful (?) advice and make useful suggestions, there was Tom who was to straighten and turn the shaft when it was welded, two helpers from the machine shop, the blacksmith's helper and the blacksmith. All this array of brain and brawn, however, could not effect the desired union.

Six o'clock approached and passed without the weld and the master of ceremonies did not seem to be put out by his lack of ability. He washed up with the rest of the men, but when they had left, he and the three helpers were still on the job. They reheated the shaft and while this was going on made several tapered plugs from ½-inch round iron about one inch long. When the shaft was hot a half-inch punch was driven into the end of the shaft, one of the iron plugs inserted and driven in tight, so were the remainder of the plugs disposed of. The condition of the shaft with the plugs inserted is shown in the line cut, the iron plugs are indicated by the black spots.

The shaft was replaced in the fire and both pieces raised to the welding heat. Two helpers on the ram performed their duty and the two pieces became one in the most up-to-date affinity style. The shaft was then dressed up at the weld, rough straightened and laid on the floor. By this time the balance of the "helpers" had begun to return and the surprise of the boss together with the satisfaction of the millwright was pleasant to see. The boss could not surpress his curiosity as to the why and wherefore of the weld, but his only satisfaction was in the remark of the smith, "Well there is such a thing as having too much help."

A New Idea for Disk Grinders With Tests

Corrugating Disk Presents Points of Abrasive. Results of Comparative Tests. The Time Consumed in Doing Some Commercial Work

BY F. N. GARDNER*

The Gardner Machine Company, of Beloit, Wis., has recently developed and perfected an abrasive disk for grinding that is a great improvement over the old style of disks.

The new principle adopted in the manufacture of these grinding disks is that of corrugating the abrasive surface, as shown in the disks in Figs. 1 and 2, but the most plainly in Fig. 2. This tilts the abrasive material so that it presents the points of it to the surface to be ground, rather than a flat surface. This principle has been patented. It has greatly increased the grinding ability of the disks, and makes them wear for a much longer period than the old style, as well as making the disks do the grinding in a much shorter time; thereby greatly decreasing the labor cost of the grinding operations.

In making the Gardner disks, shown in Figs. 1 and 2, and on the various machines illustrated, the abrasive grains are made of a mixture of carborundum and corundum with a little alundum added. These are mixed in the proper proportions to give the best results in grinding as was demonstrated by a long series of experiments and tests on practical work by the company. When these have been mixed the required bond is added and the mixture is cemented to a cloth backing. While yet in the plastic condition the abrasive grains are mechanically tilted by pressing into the disk a plate, whose surface is covered with square points.

*President of Gardner Machine Company, Beloit, Wis.

FIG. 1. NO. 1 GARDNER'S IMPROVED ABRASIVE DISK

Good Qualities

This gives the disk its corrugations, as shown in Fig. 2, and presents numerous sharp points to the metal to be ground. A careful examination of the disks made by this process will fail to show any grains with large flat surfaces fixed parallel to the plane of rotation or in other words parallel to the surface of the work to be ground.

Most other disks are made by depositing a heavy coating of glue on the backing sheet and then spreading a layer of dry abrasive grains on top of it. This causes the grains to settle into the glue and so become firmly attached to the backing sheet. Disks made like this cut freely and rapidly at first, but soon wear down to a surface that presents too much glue, and not enough of the abrasive material, to the work, owing to the grains and glue not being evenly mixed from the face to the back of the disk.

The success of this disk over others is doubtless due to the fact that the flat side of a grain of abrasive material will not cut as freely as a sharp edge, and this is made evident by the results of the tests given below. Another point that is brought out clearly in these tests is that the Gardner disks cut a trifle better in the second half of the test than in the first half, and this is due to the fact that the abrasive material and the bond were mixed together before cementing them to the cloth back; thus giving a uniformity to the cutting efficiency of the disk from the front to the back.

Disk Number	Time Used in Minutes.	Stock Removed in Cubic Inches.	Number of Times Dressed.	Average Cutting Rate Cu. In. Per Min.	Cutting Rate First Half of Time Used.	Cutting Rate Second Half of Time Used.	Life of Disk Based on Disk No. 1.	Stock Removed Based on Disk No. 1.
							Per Cent.	Per Cent.
1	754	349.85	0	.464	.442	.486	100.0	100.0
2	137	42.13	6	.307	.344	.270	18.1	12.4
3	540	113.95	0	.211	.238	.184	71.6	32.3
4	68	27.97	2	.411	.546	.276	9.0	8.0
5	71	2.41	4	.034	.062	.006	9.4	0.7
6	73	12.48	2	.171	.273	.069	9.7	3.5

TABLE 1. RESULTS OF TESTS TO SHOW THE EFFICIENCY OF ABRASIVE DISKS.

The Tests

The results of the tests carried on to prove the efficiency of these disks are given in Table 1. The tests were divided into two halves to show the wearing qualities of the different disks and they were

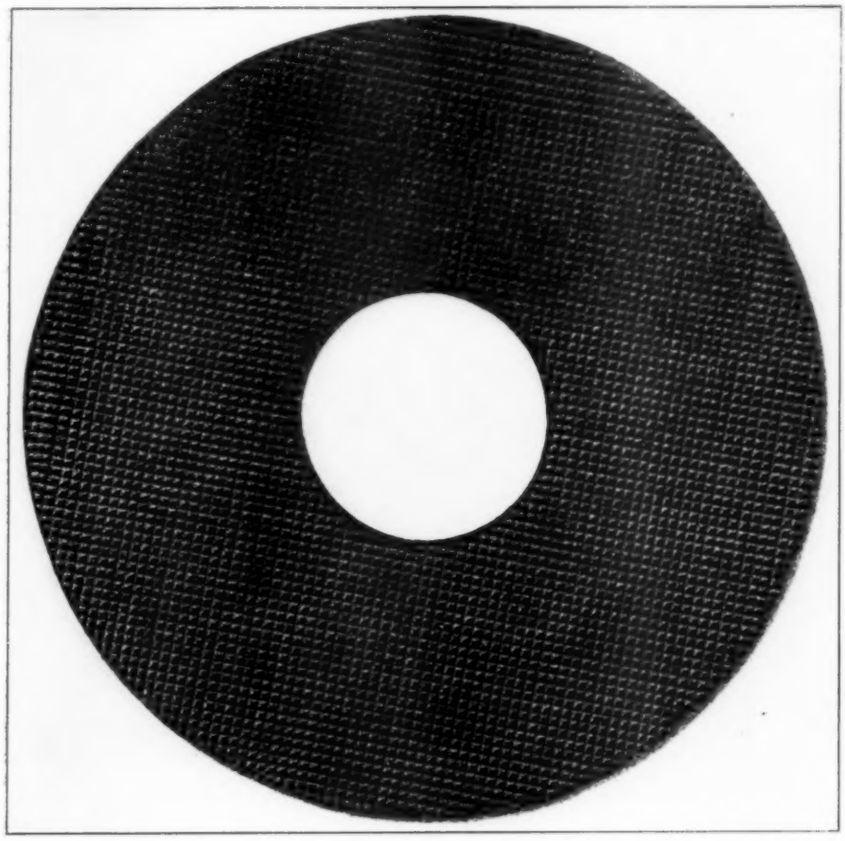


FIG. 2. DISK OF FINE ABRASIVE WHICH PLAINLY SHOWS CORRUGATIONS

all made on one machine, by the same man, with disks 20 inches in diameter and No. 16 grain, except disk No. 5, which was a No. 24 emery cloth, and disk No. 6, which was the same thing in paper. These last two, as will be seen, were very low in efficiency, although the emery paper removed five times as much

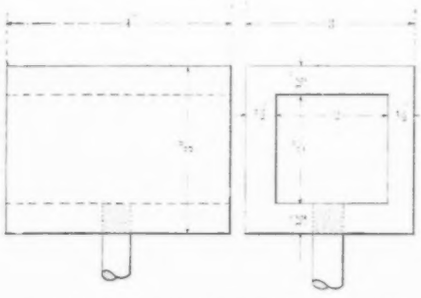


FIG. 3. CAST-IRON TEST BLOCK USED IN GRINDING TESTS

stock as the emery cloth, and they were merely used to show the comparative cutting qualities between disks made especially for grinding cast iron and the emery cloth or paper sometimes used.

Twelve hollow, cast-iron test blocks were used together, that were cast of the same iron. These were of the size shown in Fig. 3 and they were ground as shown in Fig. 4. This size gave an area of 5 square inches and when one inch of the length was ground away, it indicated the removal of 5 cubic inches.

A micrometer stop was located at the back of the table and this was set so that 0.05 of an inch would be ground off of the 12 blocks, after which it was reset to grind another 0.05 of an inch from the 12 blocks, and this operation was repeated until the blocks became too hot for efficient grinding. Then the time consumed and the amount of metal removed was noted and the blocks cooled. When the test blocks were out others were substituted and in this way several hundred pounds of blocks were converted into grindings. Grinding was continued on each of the 6 disks until they were worn to destruction.

It will be seen in the table that the Huntington emery-wheel dresser was used on all the disks tested except Nos. 1 and 3. The use of a dresser shortens the life of an abrasive disk and therefore it was not used until the surface became so dull and glazed that it would not cut the cast iron readily, and thus it was absolutely necessary to use it.

Disks Used in Tests

Of the disks used in the tests shown in the table, No. 1 is Gardner's Improved Abrasive Disk No. 126: Disk No. 2 is one that is especially recommended by the maker for the grinding of cast iron, and doubtless gave better results on this metal than it would on any other: Disk No. 3 is recommended by many as one of the best grinding disks and was probably at its best on cast iron: Disk No. 4 was considered by the makers the best all-round disk on the market until this new one was brought out, and although it fell down on the cast-iron tests, it would probably have shown much better results on steel; while

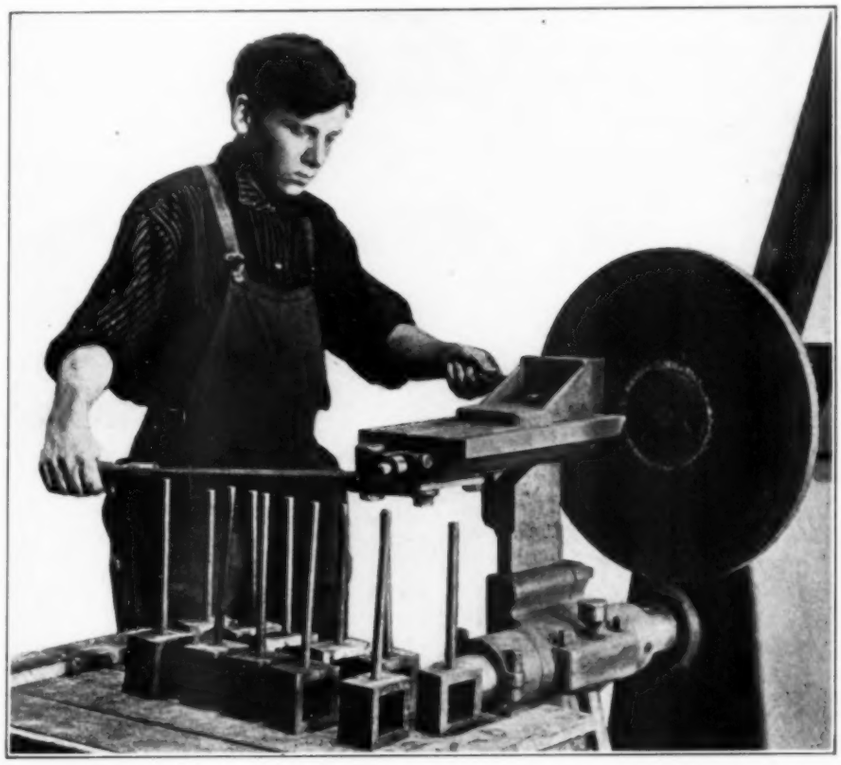


FIG. 4. GRINDING THE CAST-IRON TEST BLOCK

disks Nos. 5 and 6 have been previously described.

The reason the emery paper beat the cloth in these two is because the grains came off easier, thus presenting new cutting points to the metal, or technically it was "softer temper." The emery cloth did most of its cutting in the first 15 minutes, after which it was practically useless, but if the tests had been carried on in steel instead of cast iron the cloth would probably have equalled, if not beaten the emery paper.

The disk No. 1, used in these tests, is made especially for cast iron and is not recommended for grinding steel, but others are made that will give good results on steel.

Practical Work on Centrifugal Pump Impellers

In the practical commercial work of a shop, the disk marked 1 in the tests has also shown some very good results and Fig. 5 shows it working on some pump paddles or impellers. These were cast in a gray iron and the castings were very rough and in some places hard, which made them difficult to machine. In some places it was necessary to remove ¼ of an inch of stock. They were 26 inches in diameter and the area of the ground surface was about 50 square inches. The surface of the blades was not radial but curved, with an angle of 7 degrees to the axis, which necessitated a revolving of the paddles while grinding them, to develop the surface of a cone.

FIG. 5. GRINDING PADDLE WHEELS FOR CENTRIFUGAL PUMP

To grind these, they were mounted on a spindle that was driven by a worm gear and worm which was connected to the hand wheel, as shown. This fixture was mounted on the lever feed table and set at the required angle to the face of the grinding disk. To operate, the paddle is slowly revolved by the hand wheel, while the lever is used to press it against the grinding disk.

These paddle wheels, or impellers, were ground on the Gardner disk in 15 minutes, which included the time consumed in turning them over. When first made, these paddle wheels were turned in a lathe and it took 3 hours and 30 minutes to turn each one. Thus 14 were ground in the same time that it took to turn one in the lathe.

Grinding Latticed Plates

The racks, or latticed plates, which are shown in the grinding operation in Fig. 6, are used in the manufacture of the Gardner disks, and they are cast in a stove foundry, of the same iron as stove plate. They are cast very accurate to the pattern but the iron is too hard to machine successfully, therefore grinding is almost a necessity and no comparison between turning, or milling, and grinding can be made.

They are 23 inches outside diameter, ⅞ of an inch thick, and the rings and spokes, or ribs, that go to make up the plate are 5/32 of an inch thick. The center, or inner, circle is 6 inches in diameter. The thinness of the plates is another handicap that makes it impractical to machine them in any way, and they must be of a uniform thickness and accurately flat. The amount of metal to be ground off to make them accurately flat is about 1/32 of an inch on each side.

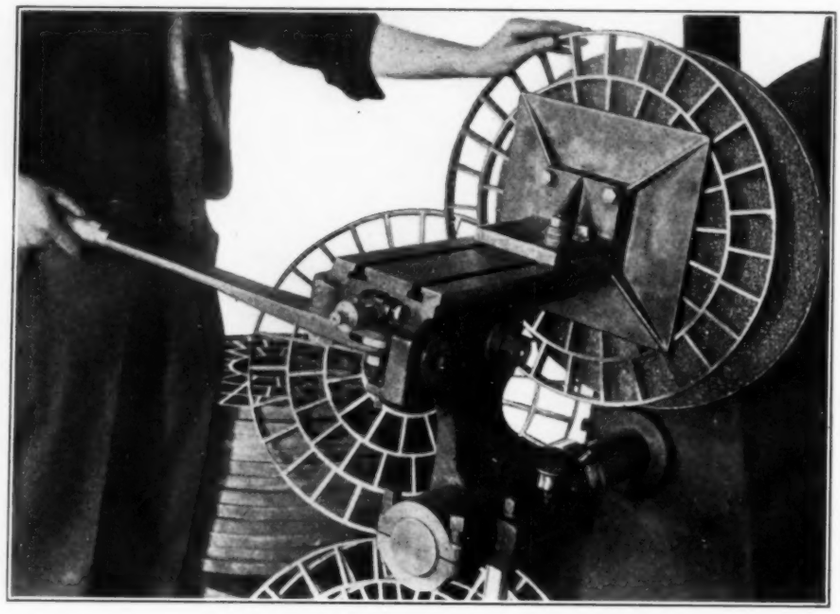


FIG. 6. GRINDING HARD CAST-IRON LATTICED PLATES

To grind them the plates are chucked, at the inner circle, on a metal disk having set-screw heads projecting from its periphery. An angle plate is bolted to the top of the lever table, as shown in Fig. 6, and this disk has a ¾-inch hole in its center that fits a stud in the angle plate. The latticed plates are hung on this stud and bear against the angle plate when it is pressed against the grinding disk by the lever. This makes the latticed plates free to revolve with the grinding disk, and the speed of its revolutions is easily controlled by the operator, by moving the center of the stud in the angle plate toward or away from the center of the spindle which carries the grinding disk.

Thus by changing the pressure on the lever and swinging the table on the rocker shaft with his hands, the operator can cause the revolutions of the latticed plates to increase, decrease, or entirely stop, while he is grinding them.

By this method the plates have been ground flat on one side, then turned over, ground flat on the opposite side, and to the correct thickness in 15 minutes.

Grinding Babbitted Boxes

Another interesting operation that was performed on these disks is that of grinding both ends of some cast-iron boxes, that had been babbitted, as shown in Fig. 7.

The boxes are for a 27/16-inch shaft, and on some of them the cap lapped over the base as much as ¼ of an inch, thus making it necessary to grind off more than this from both ends of the box. The grinding was done on the same No. 1 disk, but it was coated with a special preparation to prevent the babbitt from adhering to, and clogging, the grinding disk. The total area of surface ground on each box was 16 square inches.

In grinding them, the boxes are simply slipped on to a freely fitting stud, which is set in an angle plate that is bolted to the top of the lever table. A micrometer stop screw was used to get the boxes to their correct length. This arrangement enabled the operator to handle them rapidly.

They were ground at the rate of 75 per hour, or to be more correct 73 boxes were ground on both ends in 59 minutes, and when finished both ends were perfectly square and parallel, and the boxes were all equal in length and to the correct size.

In recent experiments conducted by the Signal Corps of the Army in order to determine to some degree the practicability of wireless telegraphy to and from a balloon, the receiving apparatus carried in the balloon worked perfectly. Sending apparatus was not carried during these experiments, but it is predicted as a result of the tests that within a short time an apparatus will be perfected that can safely and successfully be used in both sending and receiving messages from a balloon to another flying within reasonable distance and to stations within a radius of many miles.

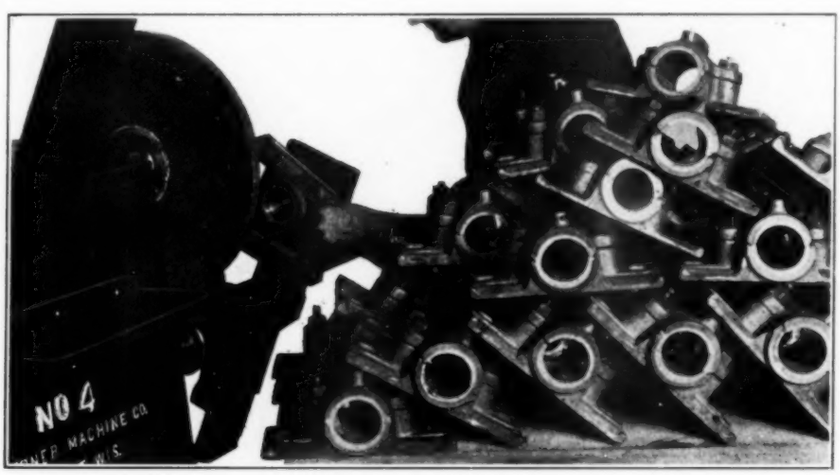
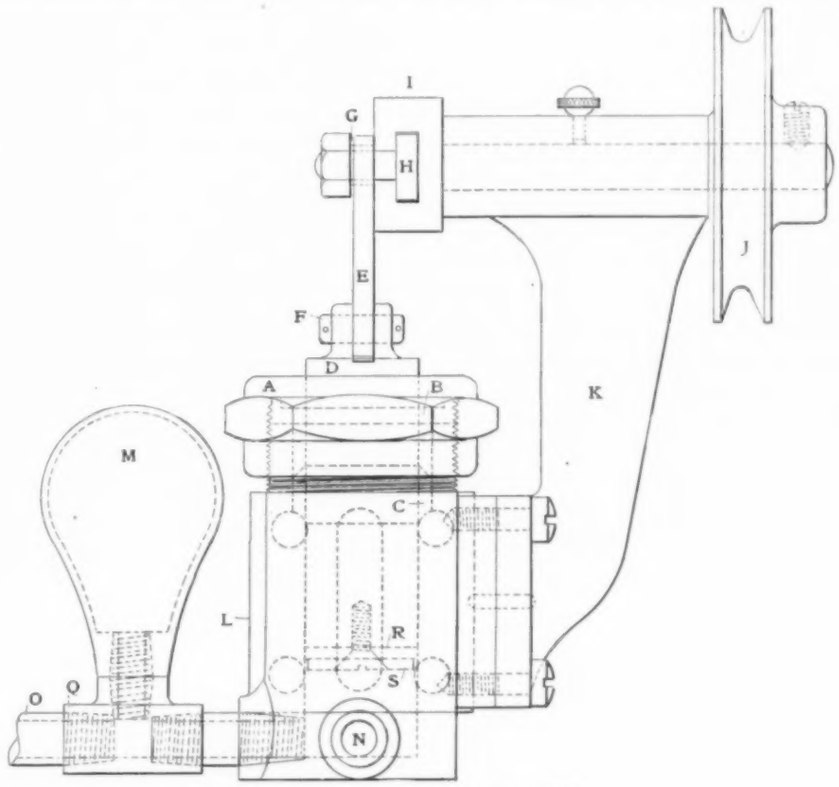


FIG. 7. GRINDING BABBITTED BOXES ON GARDNER'S IMPROVED ABRASIVE DISK

Plunger Pump for Screw Machines

By M. W. Mack

After a good deal of trouble with our screw-machine pumps, especially when using soda-water mixtures, I concluded that plunger pumps were what we ought to have on the machines. I designed one suitable for large and small machines and made six for a test. They worked satisfactorily, and it mattered not what direction they were run. We had over a hundred in use, and took off the old pumps as it was cheaper to furnish new pumps than to keep on repairing the old ones. I expected to have to replace the leather washer on the plunger, but never had any occasion to as long as I was there. We put two on the cold-metal saws, and they seemed to be just the thing for them, as we could run them at the slow speed of about 20 revolutions a minute. We also had them on other machines that required pumps, and they gave satisfaction. The accompanying sketch shows the pump. *A* is a cast-iron cap which screws on the body and adjusts the stuffing box *B* to press the packing into recess *C*. Plunger *D* is 1¼-inch cold-rolled steel slotted at the top to receive link *E* held by pin *F*. Bushing *G* is hardened and about 0.010 longer than the thickness of link *E*. Square-head bolt *H* binds the bushing allowing the link to be free on the bushing while operating. *I* is part of the shaft and has a T-slot to allow regulation of the length of the stroke. It is 1½ inches diameter and gives about 1½ inches maximum stroke of piston, the stroke being reduced by moving bolt *H* nearer the center. *J* is the driving pulley made for a round belt. *K* is a cast-iron bracket secured by screws to the pump body. *L* is the rear portion of the pump casting by which the pump is fastened to the rear of the machine. The air chamber on the outlet is seen at *M*. The inlet is at *N*; the check valves are placed at *O* and *P*. *Q* is a T-pipe fitting. *R* is a leather washer and *S* a steel washer of a little smaller diameter than the piston to keep the leather from cupping too much. Both are held by a screw. We used ¼-inch pipe on suction and discharge.



PLUNGER PUMP FOR SCREW MACHINE

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Test Indicator

Possibly some readers of the AMERICAN MACHINIST may be interested in a universal test indicator as made by A. C. Munz and myself. Our work being such as to require frequent use of an indicator, we finally decided to build one of our own design along lines that would adapt it for use on all occasions. The result is shown in the photographs and drawing herewith, and to say the least it makes an excellent tool.

The movement is mounted in a frame similar to the works of a watch, and the frame is inclosed in a dust-proof case in the top of which is a heavy watch crystal of the open-face type providing a neat and efficient covering. The dial is graduated into one hundred equal parts, each one representing one-thousandth of an inch, and the design provides for one-half inch movement of the stem, or five complete turns of the hand. This allows the tool to be used in many instances where one with less movement would be useless. For instance, measuring tapers, setting up work that is to be machined to a certain taper, chucking work that is to be turned eccentric, and, in connection with a little trigonometry, setting up work to any required angle.

As a stop to indicate when a lathe carriage has reached a certain place on its ways it has many advantages over the ordinary solid kind, and is superior to the micrometer stop because it is impossible to move the carriage up against it without registering just the amount the stem is disturbed, while with the solid stop, or the micrometer stop, its "I *guess* that is about as tight as I had it before." Used in this connection it is very convenient for measuring short steps or shoulders on work; for indicating just when to pull out the tool while cutting a thread up to a shoulder, when a hole is bored to a certain depth, etc. It may also be used as a cross-feed stop in thread cutting, a great advantage where the cross-feed is not provided with a graduated dial.

By unscrewing that part of the stem that extends through the base, or mounting piece, and removing a screw at the back, the case may be taken off the base and used on an ordinary surface gage; a short hardened point is screwed into the stem to provide a good working surface. The bell crank fits either the nose on the case or the one on the base. The case may also be mounted on the base at any angle with it, though in this position it is not adapted to get into as small places as it will when mounted as shown.

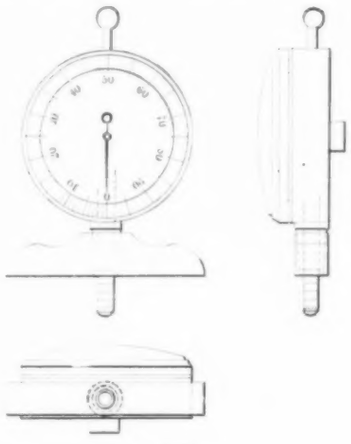


FIG. 2

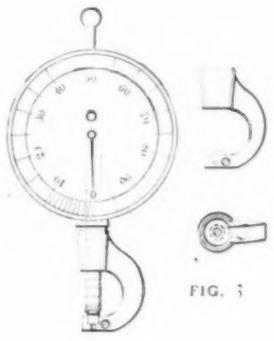


FIG. 3

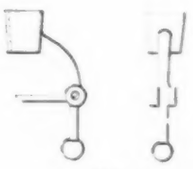


FIG. 4

FIG. 5

TEST INDICATOR ATTACHMENTS

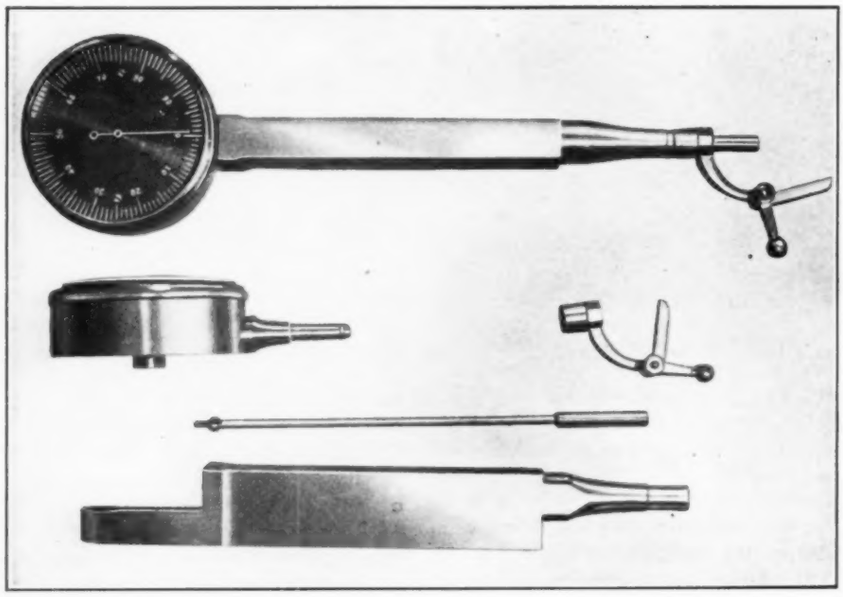


FIG. 1. TEST INDICATOR

The one-half inch movement of the stem especially adapts this indicator to be mounted on a bench lathe and used as a measuring instrument; it can readily be seen that standard length rods, in inches, may be used to set to any required size.

In the drawing are shown several attachments not seen in Fig. 1 as they were not complete when the photographs were taken, also a handle is provided for pulling the stem in to allow it to pass obstructions, and to assist in taking measurements, etc. This handle is shown projecting from the top of the case in Figs. 2 and 3.

Fig. 2 shows a depth-gage attachment, with a capacity of one-half inch; this amount may be increased by screwing points of a known length into the stem in place of the short, hardened point shown

Fig. 3 is an attachment that converts the tool into a micrometer caliper; it is very useful for taking measurements less than one-half inch, and is much more rapid than the ordinary kind. Fig. 4 shows the bell crank which is also illustrated in the photograph. This enables the tool to true up small holes and buttons and to be used in places where it is not practical to apply the stem direct.

In Fig. 5 is shown a bell crank designed to increase the movement of the hand by one half. It is useful in truing up work that it is desired to have more accurate than usual. It is of course understood that the bell cranks would be accurate in taking measurements requiring only a very slight part of the movement of the stem, their use being more for truing up work than for taking measurements.

In the photograph, Fig. 6, is shown a job on a Brown & Sharpe vertical-milling machine being set in proper position with the indicator. This job is a boring bar 4 inches square, carrying a traveling head in which is mounted a sliding tool holder which is controlled by a pin traveling in the slot shown on the top side of the bar. This slot is of irregular contour and causes the tool to bore a hole of similar shape. The part of the slot for which the bar is being set is required to bore a taper of 2½ inches per foot; this would require the taper of the slot to be 1¼ inches per foot. Figuring the taper for a distance of 4 inches we find it to be 0.4166 inch. Two points are located on the bar 4 inches apart and the bar set to show 0.4166 variation on the indicator between these two points, thus the work is readily set to the required position for machining the slot.

Watervliet, N.Y. D. TAPPEN.

A Device for Turning Crank Pins

In the manufacture of a special machine one of the problems was the finishing of the pins of the main crank-shafts. As shown in Fig. 1, these shafts were of the single-throw type, about 3 feet long over all, the throw being 4 inches and the pin 2 inches diameter by 2½ feet long. The original method of finishing was similar to the method used by many makers of steam-engine crank-shafts; a cast-iron plate, Fig. 2, having a hub bored to fit the finished shaft and containing a center hole properly located, was attached to the shaft by set-screws. To facilitate leveling on the surface plate two sides of this plate were planed parallel with the center line, but it was necessary in each case to carefully center the pin, and after mounting in the lathe, as shown, to carefully test the alinement with a surface gage. A counterweight attached to the face-plate steadied the lathe somewhat, but a high speed was out of the question. Time finishing the pins by this method averaged two hours each. Not being able to complete them rapidly enough by this method the device shown in Fig. 3 was constructed. A drum was cast about 14 inches diameter and attached by screws to the regular lathe face-plate. This drum was carefully bored to receive the finished shaft, the crank end being bored to receive the split taper bushing *T*, the rear end being provided with a clamping device not shown. Two stop screws *S S* were provided to center the shaft sidewise, this being the only adjustment needed. A weight strip *W* was cast in the interior of the drum for balance, and accurate balance was finally obtained by drilling away a portion of this strip.

A special casting was made to support the outer end of the drum, similar to an ordinary steady rest, only without the jaws.

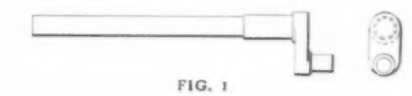


FIG. 1

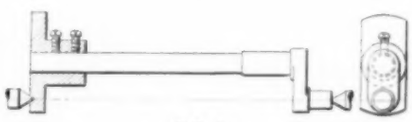


FIG. 2

TURNING CRANK-SHAFTS

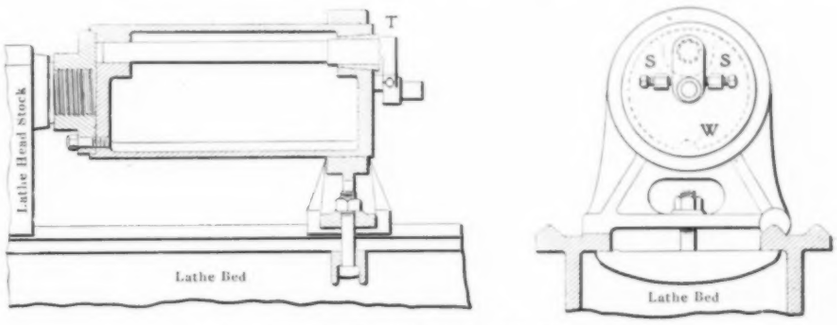


FIG. 3. DEVICE FOR TURNING CRANK-SHAFT PINS

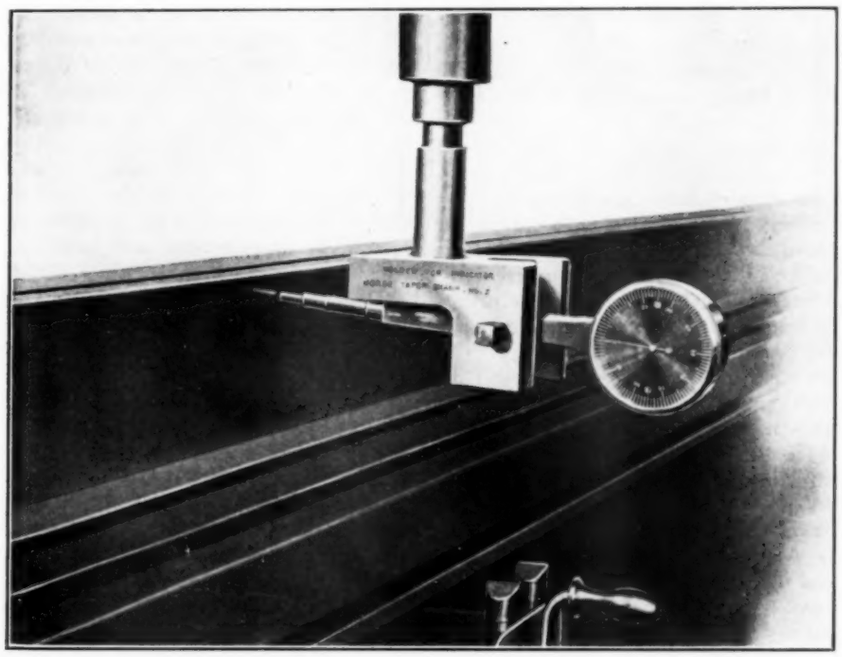


FIG. 6. TEST INDICATOR IN VERTICAL SPINDLE MILLER

This part of the device would have been much more serviceable if an adjustment had been made for wear, and could probably be lined with soft metal to advantage, although many pins have been turned with this rig without serious wear being apparent.

In practice we found it necessary to drill a hand hole through the shell of the drum to aid in entering the shaft in the rear support.

With this device we find no difficulty in finishing three pins per hour, or a gain of 25 shafts per day, and by adapting it for use on our open turret lathe, instead of the engine lathe now used, even better results are expected.

Chicago, Ill. W. GIBSON.

During the fiscal year ending June 30 1908, 1506 vessels of 588,672 gross tons were built and numbered in the United States which shows a considerable increase over previous years. Of this output there were 75 steel steamers built on the Great lakes.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Hobbing Bevel Gears with a Taper Hob

I have read with interest the various opinions expressed on pages 804 and 805, Volume 31, Part 1, concerning the practicability of hobbing bevel gears with a taper hob. On first carefully reading the account of the process, I was led to entertain strong doubts as to its generality, and I was glad to find that others and notably Messrs. Gartside and Svensson had clearly expressed their difficulties. After a consideration of the arguments brought forward by Mr. Gregory in reply to his critics I feel that, up to the present, the attack has triumphed over the defense. I fear that Mr. Gregory has a hard, if not an untenable, position to defend, and though his pleas are ingenious I scarcely think they can be termed sound.

My object in writing is to state my own difficulties with the hope of obtaining some satisfactory reply.

In the first place I do not see how the analogy used by Mr. Gregory to explain the action of the taper hob clears up the matter. I quite understand him when he says that a bevel wheel may be considered to consist of an infinite number of thin laminas or slices, each having spur teeth of definite form and pitch. I also understand him when he states that any one of these laminas could be properly formed by its own suitable and similarly pitched generating hob. In order, however, that this one lamina may be produced, the hob in question must have many cutting teeth; a large number is required if the number of the teeth in the lamina to be cut is large, and a less number if the number of spur teeth is smaller.

The teeth must be regularly pitched; that is, they must be formed by cutting grooves across the teeth of a screw of uniform pitch and then backing off the cutting edges so produced. Now, it is not possible to regard the taper hob as consisting of an infinite number of single-toothed hobs. In fact the number of cutting edges is strictly finite, as it is the product of the number of convolutions by the number of gashes per convolution. Thus, if we turn to page 344, Volume 31, Part 1, the illustration shows a hob with 80 cutting teeth; this at best can be considered only as consisting of 80 hobs each having a single cutting tooth.

The analogy breaks down, therefore, unless Mr. Gregory can show how any one lamina, among the infinite number in a bevel wheel, can be cut by the appropriate single-cutting tooth in the taper hob of corresponding pitch. For it follows clearly that each of such spur-wheel shells must either be cut by a single cutting tooth in different positions, or by a number of such teeth of varying pitch.

A geometrical demonstration is needed to clear up this point which I fear has been obscured rather than elucidated by the attempt to reason from analogy.

A Limiting Case—The Crown Gear

Turning now to a limiting case, the crown wheel, it is sound engineering instinct and not perversity which has led your correspondents to show the difficulties which must be cleared up in this direction. The best way to discover the soundness of a geometrical principle is often to take an extreme case and analyze

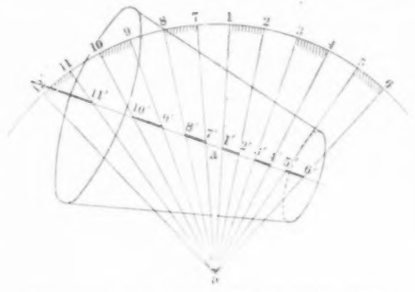


FIG. 1. DIAGRAM OF CROWN GEAR AND TAPER HOB

it. If that case stands the test of criticism we may rest satisfied, if not we can proceed to inquire whether the cases which arise in practice approximate to the doubtful case.

Mr. Gregory answers the critic who has pointed out the difficulties of interference, in the case of hobbing a crown gear, by drawing attention to the fact that the axis of the hob is not set so as to be perpendicular to the radial direction of the central tooth operated upon. This inclination of the axis, he says, is necessary and vital inasmuch as it compensates for increasing pitch on the one side and decreasing pitch on the other, and thus obviates any tendency to interference which may exist. It is to this point, therefore, that attention must be devoted. Turning to Fig. 1, let us suppose that the radiating lines 01, 02, 03....012 are the traces of the sides of the teeth of a crown wheel upon the pitch cone (which in the case of a crown wheel has, of course, degraded into the form of a disk) so that the tangent plane and the cone are coincident. Let the line 6'-11' represent the line of contact of the pitch surface of a taper hob with the pitch surface of the crown gear. The projection of the axis (which in a plan view will coincide with the line of contact) is inclined at a considerable angle to the central tooth line *Oa*. The points of section of this line of contact 6'-11' with the traces of the crown teeth are 6', 5', 4'....11' and the intercepts lying within the teeth have been thickened, 5'-6', 3'-4', etc., while the fainter portions are those which lie within the inter-spaces.

Now it is quite evident from inspection that though the spaces to the left of *a* along the line of contact do show successive increase, the rate of increase is not uniform and would, if the limits of the diagram were extended, quickly become infinite. Again, on the right of *a* though at first a tendency for the intervals to decrease may be encountered, yet that tendency very quickly ceases and the increase again becomes infinite. In the language of geometry it is impossible that a pencil of rays spaced at uniform angular intervals should divide a transversal into segments whose successive magnitudes uniformly increase in the rates of their distance from some point in that transversal. The tendency to correction, therefore, exists only in places; its limits are quickly overpassed.

A Difficulty

We now encounter a very serious difficulty; as the teeth of the crown wheel are radial they are divergent, while the teeth of the hob being portions of an equiangular spiral thread are uniformly inclined to the axis, and, therefore, parallel. It is obvious that in the figure, the direction of the hob teeth coincides with the central tooth space at one point only, *O a*, while the deviation from coincidence with the radial direction becomes greater and greater as we encounter hob teeth more and more remote from *a*.

The effect of this will be to cause interference of a most unmistakable kind. It is, of course, unnecessary to state that if a bevel or other gear is cut by a hob it will gear perfectly with the worm of which the hob is the mutilated form. In Fig. 2 we have a half plan *a b d c* of a worm whose axis is *o c*, and which has been formed by causing the thread to trace a logarithmic or equiangular spiral path round the pitch cone at the same time that its form or profile, while remaining always similar, is reduced uniformly in scale, so that all its dimensions are proportional to the distance from the apex. A half-section is shown below, *d c f e*,

while a development of the conical-pitch surface extends within the limits of the annular segment $E F G H$. It should be observed that the traces of the teeth are all portions of the same logarithmic spiral. Thus the segment 3-3′-4 may be applied to the segment 1-1′-2, so that while the center O remains the same, the point 2 falls on the point 3, and in that position all the points 1-1′-2-3-3′-4 would lie along one continuous spiral.

Superimposed upon this development of the worm surface is the dotted partial development of the pitch surface of a bevel wheel $L M O N$ whose tooth interspaces are S', T', U', V', W', Y', Z'. The line $P K$ is a radial line to the center K from the point P and $P R$ is the tangent at P. The worm is supposed to be placed so that its axis is inclined to the tangent at the spiral angle α and so that its pitch coincides with the pitch at the point P. The traces of the worm teeth on the developed pitch surface of the worm are shown shaded at S, T, U, V, W, X, Y, Z.

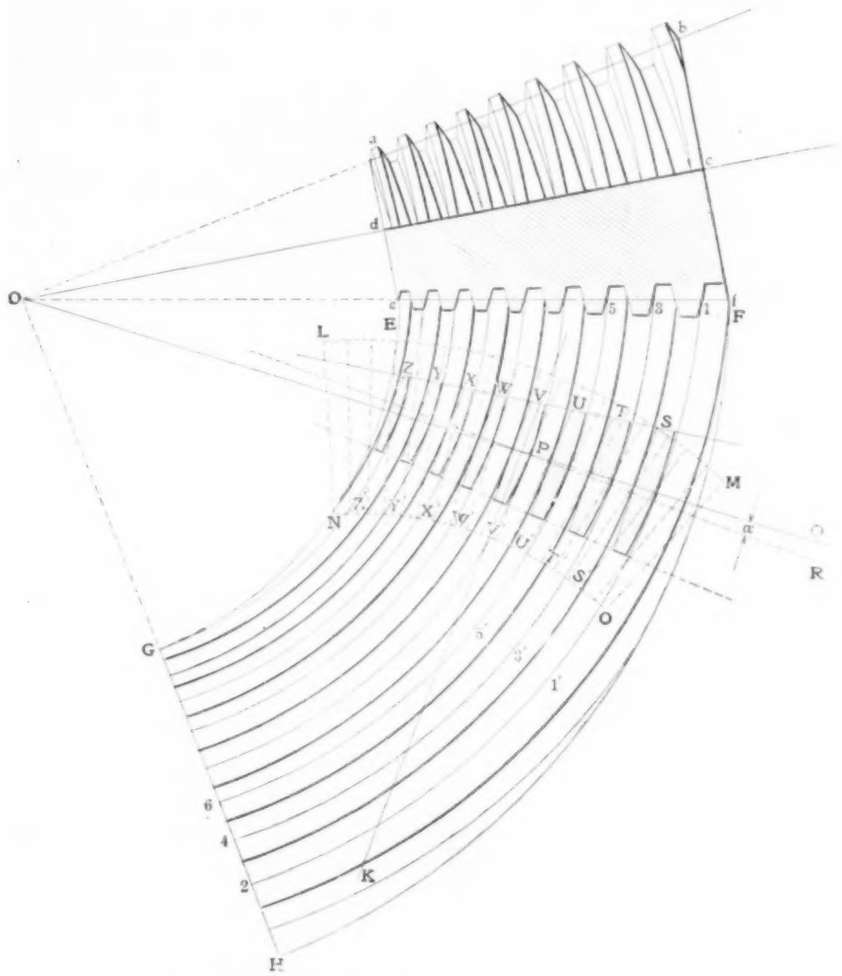


FIG. 2. DIAGRAM OF BEVEL GEAR AND TAPER HOB

It becomes clear on inspection that as we depart from P on either side there is no correspondence between the positions occupied by the worm teeth and the interspaces of the developed bevel gear with which they should mesh. If the development were that of a crown wheel or even of a bevel wheel of moderately large apex angle, the most serious interpenetration would take place, and it would be quite impossible for the gears to mesh. If, however, the angle of the assumed bevel wheel is supposed to be reduced it becomes conceivable that a limit may ultimately be reached at which absolute interference may be very small, so small in fact as to be negligible. It is still, however, quite inconceivable that the gears could transmit uniform angular motion, for we have only to conceive of uniform motion being imparted to the worm, when the traces of tooth profiles would commence to move along $Q o$ at a logarithmically increasing or decreasing rate. Thus if the motion as viewed from Q were counter-clockwise, the motion of the profile traces would be from Q to o, and the velocity of translation would be different at every point, being in fact everywhere proportional to the distance of the point considered from the apex.

Conclusions

The conclusions which I have been driven to are as follows:

1. The method of taper hobbing applied to bevel wheels breaks down entirely for crown wheels.

2. Bevels whose apex angle is small can be cut, though not correctly.

If the conclusions stated are incorrect the errors can be pointed out; but at any rate my remarks will serve to show some of the difficulties which are present in the mind of those to whom the problem of taper hobbing is fresh.

In conclusion I think that it may be looked upon as an open question whether or not future gear cutting will be performed by rotary cutters. Indications are not wanting that point to a single reciprocating tool as capable of performing a higher duty, and producing more accurate work than the multiple-cutting teeth of hobs or profile milling cutters.

This opinion will not be popularly held just yet, but those who have seen a really efficient gear cutter on the reciprocating principle have confessed to considerable surprise. Now the reciprocating tool is pre-eminently suitable for cutting bevel wheels, and I do not think that the method of taper hobbing is likely to prove a serious rival, especially should the limitations anticipated in this discussion be realized.

Robert A. Bruce.

New Brompton, England.

That Turret-tool Holder

I think I am safe in saying that I was the originator of a turret tool holding a number of tools for lathe or screw machines, as the tool holder recently described in the American Machinist was gotten out June 10, 1901, and the model from which photo was made is the turret-tool holder that was worked up at the Baush Machine Tool Company in 1901. I applied for patent on same, March 12, 1902, and patent was allowed February 12, 1904, but not issued, as I did not think at that time that the tool was strong enough to do the work required, and have waited until this date. My new turret-tool holder is adapted for high-speed steel, and stands up under heavy cuts.

F. E. Bocorcelski.

Springfield, Mass.

The "Ads" as an Educator

I don't know as I have a more artistic eye than the average mechanic, but it has always been my custom to look over the advertisements in the different journals I take and have derived much pleasure and profit therefrom. A well executed cut of tools and machinery, such as the American Machinist invariably publishes, teaches me outlines, shadings and contours that I would have no other means of obtaining. It often happens in making a drawing of some idea I may have that it does not strike my eye as being just right,

and the chances are if I look over a copy of the paper I will come across something of a similar nature that will instantly show me where the trouble is and I can rectify it at once.

The constant improvement you have shown in this department in the last 10 years is worthy the notice of your appreciative readers the world over.

E. St. Louis, Mo. T. Toot.

Boring and Turning an Ellipse

On page 702, Volume 30, Part 1, is described an operation of boring an elliptical die with the statement that the process was apparently inexplicable. I believe that the following discussion will satisfactorily explain the operation.

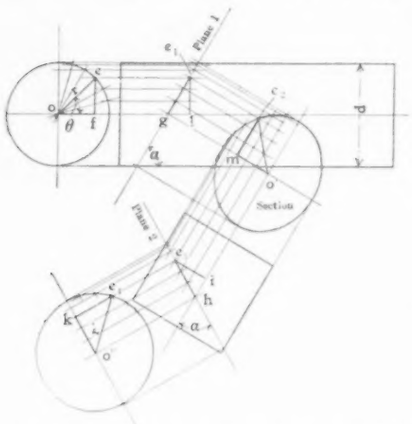


FIG. 1. DIAGRAM ILLUSTRATING PRINCIPLE OF ELLIPTICAL TURNING AND BORING

The principles involved are: 1. If a circular cylinder is intersected by a plane at a given angle α with its axis the resulting section is an ellipse, of which the minor axis is the diameter d of the cylinder and the major axis is d *cosec.* α. 2. Take a cylinder, the right section of which is the above ellipse. If there is passed through it a plane containing the major axis of the right section, and at the angle α with the longitudinal axis of the cylinder, the resulting section is a circle, whose diameter is the major axis of the above ellipse.

This checks up very nicely on the drawing board, as seen in Fig. 1. It also checks easily by trigonometry as to the two main diameters of the large circles; each is d *cosec.* α. To establish the proof as to the intermediate points on this curve, the following method was employed:

The Proof

Assume a circular or right cylinder of which the radius is r and diameter d, as in Fig. 1. Pass plane 1 at an angle α through the point e taken anywhere on the surface of the cylinder. The line $o\,e$ makes an angle θ with the horizontal. Drop a perpendicular $e\,f$ from e to the horizontal.

Then $e\,f = r$ *sin.* θ and

$$o\,f = r \cos.\ \theta.$$

Drop a perpendicular from e to the minor axis of the elliptical section. This is $e_1 g$ in the projector and equals $e_2 m$ in the section, therefore $e_1 g = e_2 m = e_1 l$ *cosec.* $\alpha = e\,f$ *cosec.* α. Now $o' m = o\,f$ because $e\,f$ and $e_2 m_1$ are in the same plane and $o' m$ and $o\,f$ are the perpendicular distances from the same parallel line to that plane.

Now take the cylinder of which the right section is the above ellipse. Pass plane 2 through point e_3 on the surface at an angle α with the axis $h\,i\,o'$ as shown. Drop a perpendicular from e_3 to the axis $h\,i\,o'$, which is shown as $e_3 i$.

Now $e_3 i = o' m = o\,f$, and

$$e_3 h = e_3 i \text{ cosec. } \alpha$$
$$= o\,f \text{ cosec. } \alpha = o'' k.$$

also $e_4 k = e_2 m$ because $o' m$ and $o'' k$ are in the same plane and $e_4 k$ and $e_2 m$ are each the perpendicular distance from the same point to that plane.

Therefore,

$$e_4 k = e\,f \text{ cosec. } \alpha,$$

and

$$r' = \sqrt{e_4 k^2 + o'' k^2}$$

$$= \sqrt{e\,f \text{ cosec. } \alpha^2 + o\,f \text{ cosec. } \alpha^2}$$

$$= \sqrt{r^2 \sin.^2 \theta \text{ cosec.}^2 \alpha + r^2 \cos.^2 \theta \text{ cosec.}^2 \alpha}$$

$$= r \text{ cosec. } \alpha \sqrt{\sin.^2 \theta + \cos.^2 \theta}$$

$$= r \text{ cosec. } \alpha \sqrt{1} = r \text{ cosec. } \alpha$$

which is a constant, $\therefore$ r' is the radius of a circle.

Application of the Proof

The application of this proof may be seen in Fig. 2. Here we have a piece of work blocked up on the compound rest of a lathe (looking down on the top). The tool is held by a holder bolted to the face plate of the lathe. The path of the tool is necessarily a circle. If the work is fed across the bed as indicated the right section of the piece will be an ellipse, as shown by Fig. 1. The ratio of the minor to major axis of this ellipse will be *sin.* α. The path of the tool lies in a plane which corresponds to plane 2, Fig. 1, intersecting the elliptical cylinder.

In an actual operation the following points must be observed. The tool must come to a sharp point, for if it had any appreciable width, it would dig into the finished work in the position shown, or would cut below the finishing line when on the opposite side. This would prevent rapid work, as the feed must be very fine, and would also make it difficult to get a good finish as with a broad-nosed tool.

The plane of the path of this tool must pass through the intersections of the center lines of the compound rest and spindle. The length of work to be turned is limited, as the finished work would soon strike the arm extending from the face plate and holding the tool.

The setting for boring is also shown. In this case the tool is held in a boring bar. The length of cut is here limited, as before, as the work will soon strike the boring bar. Another impractical phase of the turning is the overhang the work must have on the compound rest, especially where the length to be turned is great.

Again, in making dies, it is customary to have the hole counterbored from a short distance, as a clearance for the punchings. This is obviously impossible, so long as the point of the tool does not pass in a plane parallel to the surface of the top of the die.

Cleveland, Ohio. G. Harry Case.

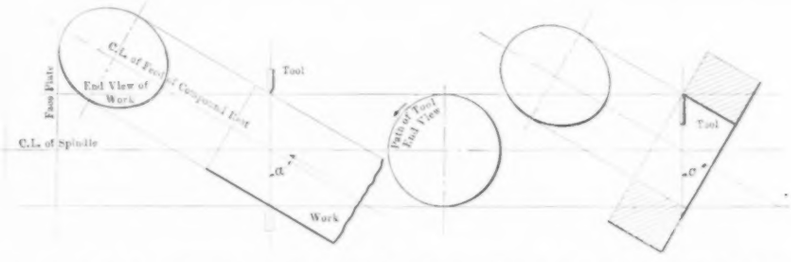


FIG. 2. DIAGRAM ILLUSTRATING PRINCIPLE OF SETTING TOOLS AND WORK FOR ELLIPTICAL TURNING AND BORING

The Efficiency of Automobile Mechanism

On page 965, of Part 1, of the present volume you make a statement regarding the efficiency of automobile mechanism, which the writer believes to be wrong. While superintendent of a large repair shop, where a very accurate dynamometer, especially constructed for testing automobiles was installed, and where numerous tests of both American and European cars were made, the efficiency shown was never anywhere near that given in the item mentioned.

The best showing made by any American car tested was 83 per cent. efficiency at the rear wheels, and this with the motor exhausting directly into the atmosphere, and not through the muffler.

The highest efficiency of any American car tested when motor was exhausting

through muffler, was 82 per cent., and from this down to 59 per cent., the average being 75 per cent., or a loss of 25 per cent. in transmission, between the motor and the rear wheels.

The efficiency of the European cars was slightly better, being in one case as high as 87 per cent., with the exhaust from motor going through the muffler, and the lowest efficiency being 66 per cent., the average 77 per cent., or a loss in transmission mechanism of 23 per cent.

Newark, N. J. ALBERT W. JACOBI.

Notes on the Design of a 36x36-inch Planer

In going over the energy of the table for the 36x36-inch planer on page 873, Vol. 31, Part 1, I cannot quite understand the formula $\frac{1}{2} M V^2 = 150$. The 150 is correct but I get it another way,

$$E = \frac{W V^2}{2 g},$$

where W = The weight,
g = Acceleration due to gravity = 32
V = Velocity in feet per second.

Then

$$E = \frac{2400 \times 120 \times 120}{64 \times 60 \times 60} = 150.$$

If, however, his formula had read

$$M V^2 = 150$$

it would have been correct, as

$$M = mass = \frac{W}{2 g}$$

Entropy gives 460 pounds for the effective pull of the belt or 184 pounds per inch of width. This in my opinion is excessive. I think it will be more like 40 pounds per inch of width or 100 pounds effective pull of belt.

The stored energy to overcome at reversal I take it is the energy of the two fast pulleys plus the energy of the table, or $962 + 962 + 150 = 2074$ foot-pounds per second. The work of the fast pulley tending to draw the table up is

$$\frac{40 \times 5 \times 4000}{2 \times 60} = 6666$$

foot-pounds per second. The table will then be reversed in

$$\frac{2074}{6666} \text{ second} = 0.31 \text{ second.}$$

If the table travels at 120 feet per minute the distance the table will travel before the reversal takes place is

$$\frac{120 \times 0.31 \times 12}{60} = 7.44 \text{ inches.}$$

This answer varies with the speed of table. Taking Entropy's method

$$\frac{\textit{Energy of pulley}}{\textit{Effective pull of belt}} = \frac{962}{460} = 21$$

feet of slip on pulleys or

$$\frac{2.1 \times 12}{6}$$

on the table = 4.2 inches is hardly practical, as the belt pull and the energy of the pulleys are constant for all the speeds of table; the 4.2 inches will also be a constant which practice proves false.

Taking the effective belt pull at 40 pounds per inch of width as suggested previously the horse-power at reversal is

$$\frac{5 \times 40 \times 4000}{2 \times 33{,}000} = 12.12,$$

which I think is certainly nearer the mark than 56 horse-power as given by Entropy.

Keighley, England. C. P. H. B.

An Expanding Square Hole

The wooden model spoken of by E. A. Dixie in his article on an expanding square hole is practically a reproduction of the molds used throughout France and Belgium in the tile factories for making cheap tiles for pavement.

As the story runs, their discovery is due to a very young apprentice whose name is lost to posterity. One day he was playing in the clay pile of the tile factory; he found four pieces of wood, pieces cut from ends of boards, and assembling them, as shown in Fig. 1, he began making small square tiles. The boss, coming at that moment on the premises, kicked them out, but saw the possibilities of the system and made wooden forms, using triangular pieces with a corner cut off inside of a frame; nailing them in the position giving the desired size of tiles.

Now these molds are extensively used for four- and six-sided tiles. For square types, they are composed of a cast-iron base with four ribs cast on the sides; these ribs give the strength necessary when the earth is pounded and pressed in the mold. The base has slots in the bottom through which slide bolts maintain the moving pieces, as shown in Fig. 2.

For hexagonal types the mold is hexagonal and built on the same principle (see Fig. 3).

As for mechanical application, I saw in the shop of a country blacksmith and farrier a tap wrench with four pieces held in place by set-screws, as shown in Fig. 4. I do not know how long that rusty old thing had been in use, but anyhow the principle is not of yesterday, for I heard the story given above as one told by his grandfather to the old man who told it to me.

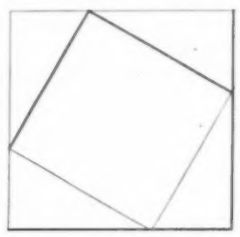
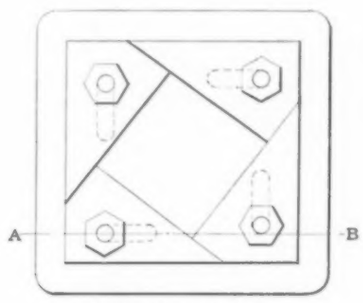


FIG. 1



Section through A-B

FIG. 2

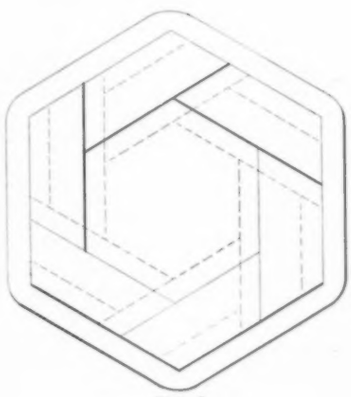


FIG. 3

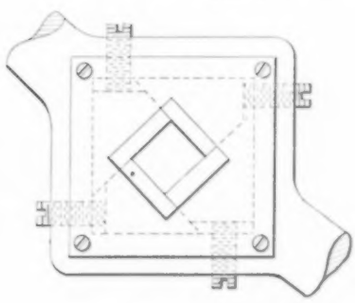


FIG. 4

AN EXPANDING SQUARE HOLE

Erie, Penn. P. FENAUX.

AMERICAN MACHINIST

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What Is a 14-inch Lathe?

In comparing the dimensions of lathes built by different makers one cannot help being struck by the difference in capacity of those listed as the same size and this leads to more or less confusion among both makers and buyers.

In the American usage of the term, a lathe with a 14-inch swing will carry a piece of work 14 inches in diameter so that it will just clear nicely over the ways, but we find some lathes listed in the same manner that will swing a piece of work 15 or 16 inches in diameter so that the size designation becomes a misnomer. True it is often convenient to be able to swing a little larger piece at times and it does no harm to anyone to allow an inch or two more swing, but why not designate it by its actual capacity instead of the smaller dimensions?

Our milling-machine friends have reached an agreement whereby a certain number machine shall have the same table travel and general capacity so far as size of work goes, but it leaves them an unrestricted range for individual ideas in the methods of driving the cutters and the work, in the amount of power to give the machine and in fact everything except the length of cut that can be taken, so that it does no more than place every maker on an equal footing so far as the table travel is concerned, but it enables a customer to know that a No. 3 machine of one make will handle the same size piece as any other No. 3. The way in which it will do the work, the time it will take, and all the other essentials depend on the individuality of the worker, as they should. Would not a similar argument among lathemakers be a good thing all around?

A Uniform Bill of Lading

One important matter that will be brought before the Commissioners on Uniform Laws, when they meet at Seattle, Washington, in the latter part of August, is a request for a new law providing for a uniform bill of lading. These commissioners are appointed by the governors of the various States, and they will be urged to take action that will draft a new bill on this important matter and arrange to have it introduced at the next session of congress.

Already commercial bodies of various cities are arranging to send committees to appear before the commissioners and to urge action that will put an end to what shippers term "the gross abuses that now make bills of lading unsafe instruments of credit." The advantages of this uniformity have been set forth in the daily press in much detail and we do not need to repeat them here. But to the engineer one interesting phase of the matter is the movement toward standardization in business methods. The advantages of standards are so vital in connection with material things, and are so well recognized by manufacturers that we wonder that so little standardization has crept into the mechanism of business. We believe that in this field, at least, business interests can learn from the engineering profession.

The Value of Visitors

The old-time notion that shop visitors were a set of busybodies, prying into other folks' business and spying out the result of your labors, has given way in most cases to a welcome more or less hearty in accordance with the broad-mindedness of the individual. Managers are realizing that it is practically impossible to keep many methods secret even if they desired to do so, knowing that where men drift from shop to shop, many so-called secrets go with them. They also know that the man who must improve his method by copying someone else is very apt to keep at least one lap behind in the race. While none of us should hesitate to adopt improved methods wherever we find them, and should be equally willing to have others copy our ways, the man who depends entirely on copying the ideas of others is hardly to be feared as a competitor.

But there is another side to the question of shop visitors—the actual and positive benefit to your own shop. Adverse criticism isn't always pleasant and sometimes the visitor feels bound by courtesy to admire all that he can without downright hypocrisy and to remain silent when he cannot praise. This may be flattering to our vanity, but it is the reverse of being helpful and it might be well to make the price of admission to the shop a promise to freely criticize anything that does not seem to be up-to-date in every way.

Of course this means that we will have much unfair criticism, that we will be told of the advantages of a certain boring machine over a lathe for that particular job, which may or may not be true in our case. If there are special reasons why our choice is best, the criticism does no harm, while if it is true, the sooner we know it the better, whether we can take advantage of it or not. If the criticism hurts our pride, it is better to conceal it and to remember that one truth hurts more than a hundred faulty criticisms.

The head of one of the largest concerns in the world is reported to have said that it was impossible to estimate the good they had received from the criticisms of visitors, that it kept them on their mettle to be so equipped that criticism was uncalled for and that the only departments which were really behind the times were those which tradition had said must be kept away from the gaze of visitors.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A New Milwaukee No. 3 Milling Machine

This is an all-geared machine, the makers having abandoned the use of cone-pulley drives on all milling-machine construction. Figs. 1 and 2 give a good general idea of its appearance.

The frame is of box section and has only five openings, the door and the oil reservoir at the base. The cabinet is walled on all sides, so that the box section is maintained throughout. The cabinet only extends about half-way down the length of the door, the bottom part being a reservoir for cutting lubricant. The third opening is covered by the plate carrying the speed-changing levers and allows the internal mechanism to be reached from the outside. The other two openings are at the back, the upper one for the feed-changing mechanism and the lower for the connections between the single driving pulley and the gearing inside.

The Driving-gear Train

The pulley runs 350 revolutions per minute and the gearing gives a 3½ to 1 reduction, the larger gear running idle on its shaft and being free to move endwise. This and another gear on the same shaft carry a hardened steel clutch and the latter gear drives the feed and also the pinion *V* in Fig. 3. The clutches are positive, and are used in starting and stopping the machine, being made practical by the slow constant speed of these clutches regardless of the speed of the machine. This allows lever 1 to control the starting or stopping of the machine. On shaft *B* is pinion *W* meshing with *D* which is an idler and swings in the bracket *X* having teeth cut at *A* so that the idler can be swung into mesh by the handle 11. The relative position is not correct in Fig. 3, as *D* meshes into the cone of gears above.

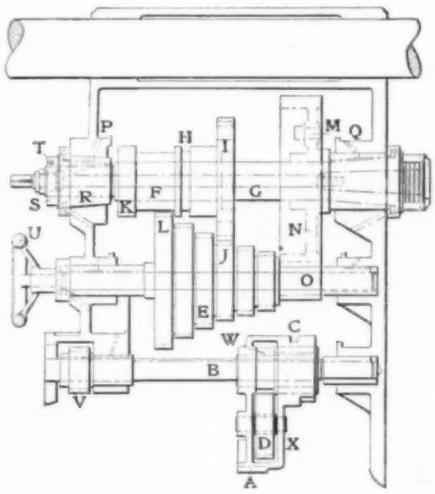


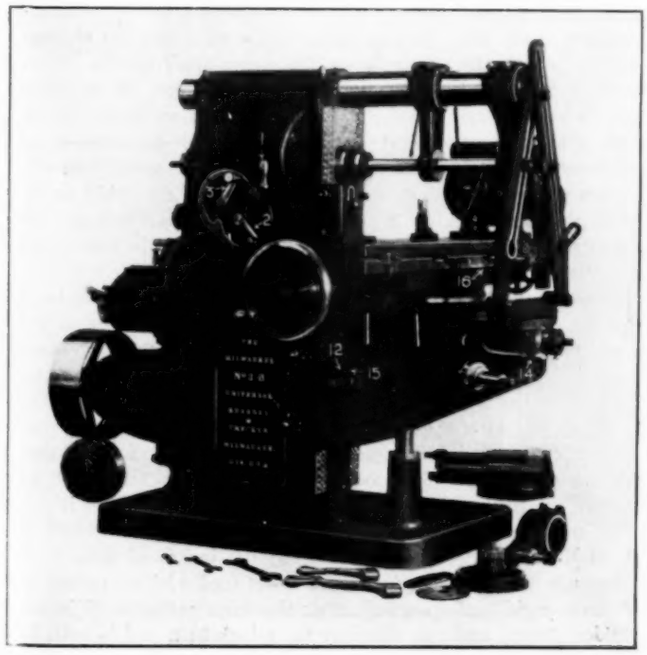
FIG. 3. SOME DETAILS OF THE GEAR DRIVE

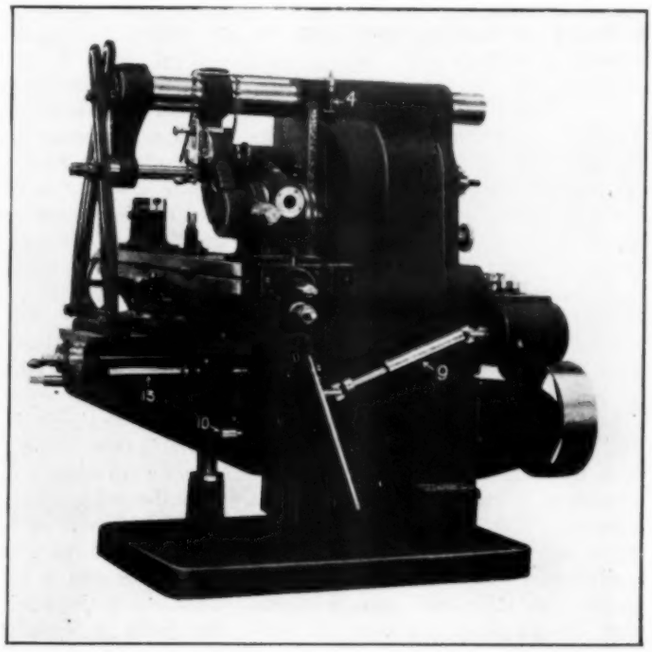
The endwise location of the gear *D* is determined by handle 2, which operates a gear inside, moves a rack, and with it the gear *D*.

At the end of the cone *E* is pinion *O*, which drives *N* idly on the spindle unless sleeve *F* with gears *I* and *K* are moved to the right by lever 3 and a rack inside so that a hole in *I* engages the pin *M*, then *M* drives the spindle *G*. Two other speeds are secured from *I* and *J*, and from *K* and *L* being in mesh, and these three being available for each of the six speeds of the cone *E* gives 18 speed changes, as indicated by speed plate under lever 2. The wheel *U* allows the spindle to be turned by hand if needed for any purpose. Oil is pumped from the small oil reservoir at the base to pockets *P* and *Q*, and there are also openings in the pipe so that oil is delivered to the gears themselves. The oil from the main bearings works down to the others and with the oil thrown from gear to gear, makes a thorough lubrication for the driving mechanism, including the driving-pulley shaft at the back. This oil supply continues as long as the main driving shaft runs, regardless of the machine itself.

Cutter Lubrication

The cutter lubricant is supplied by another pump, located inside the cabinet, and this only runs when the machine is being





FIGS. 1 AND 2. TWO VIEWS OF NO. 3 MILWAUKEE MILLING MACHINE

used. This system has a relief and pressure-regulating valve, so that it can be varied to suit the work; it comes out of the top in connection 4. It is difficult to return a large supply of lubricant from a table of the knee type, and special means have been taken for accomplishing this. Oil pockets are cast at each end, and are partitioned at half depth by screen 5, Fig. 4. Channel 6 is also divided into an upper and lower story by the steel strap 7. The course of the lubricant is from the work to the table, through the T-slots to the strainers at each end, down into the lower part of the channel and to the center of the table where it escapes into the telescopic slide, which is so designed that the hole in the table never runs beyond the swivel carriage. For cast iron the screen is replaced by a strip of steel to prevent the dust from working down into the channels.

The Feed Changes

The feed is driven from the constant-speed shaft through gearing quite similar to that shown for the spindle drive, these gears also running in oil. The index plate shows the rates of feed in inches per minute, rather than in thousands per turn of spindle. There are 12 changes of feed, varying from ½ to 16 inches per minute, or from about 0.0015 per turn of spindle for small cutters to a little over 1 inch per turn for finishing cuts with large cutters. From the feed box the power is transmitted through the universal-joint shaft, Fig. 2, direct to the knee, where a spur-gear reverse is provided, operated by the handle 10. This handle slides a clutch between two spur gears running in opposite directions. The machine is provided with vertical, table, and cross-feed, and means are provided to prevent the accidental engagement of more than one of these feeds at a time, and also to make it clear to the operator, without experiment, which feed he is about to use. For each of these three feeds there is a hole drilled in the side of the knee, and stamped below are the words "Vertical-Table-Cross," and the location of the plunger 11 determines which of these feeds will be engaged when the operator starts the machine. This is shown set for table feed.

The lever 12 is connected by means of a cross-shaft to a clutch on shaft 13, and in the positions for cross or vertical feed this clutch is withdrawn, so that the table feed becomes inoperative. In the position shown, the handle 14 can be raised which engages a clutch to start the vertical feed, a downward movement of this same handle would engage the cross-feed, but the lever 15 strikes against the plunger 11 and prevents such engagement, and in a similar manner engagement with the vertical feed is prevented when the plunger is set in the opposite hole marked "Cross." When the plunger is in a central position, it passes through the lever 15 and locks it against movement in either direction, so that neither cross nor vertical feed can be engaged, and in this position the clutch on shaft 13 comes into engagement with the drive gear in the knee, and the table feed becomes operative and is engaged or disengaged by the handle 16. Adjustable trip blocks are provided to trip the feed at any desired point, and fixed trips are provided at each end of the stroke of all the feeds.

Ball-bearing thrust collars are provided on all feed-screws. To prevent the knee from becoming distorted, on account of clamping, or from strains produced by the action of the cutters on the work, it is cast without a hole through the top. This makes the machine more rigid and less liable to distortion under strain, and also permits greater cross-range and consequently wider tables on universal machines. This machine has a table 14 inches wide, 12 inches of cross-range, and can be swiveled to an angle of 52 degrees, utilizing the full table travel. It can also be swiveled through 360 degrees and the table feed remains operative at any angle. The braces are so constructed that they can be removed from the machine without removing any nuts. They are very simple in construction and are tied together by a bolt at the top.

The Dividing Head

Fig. 5 shows an enlarged view of the universal dividing centers. The worm wheel is on the front end of the spindle, so that it can be very much larger in diameter than if it were placed in the interior of the head. This larger diameter tends toward greater accuracy, and the placing of the index plate and the plunger directly on the worm-shaft avoids errors that might arise on account of indexing through gearing. This also allows larger spiral work than could be considered otherwise, and the change gears connecting the worm-shaft with the table screw 17 have been made strong enough for heavy work, as can be readily seen from the brackets 18 and 19.

To facilitate setting the universal head at any angle relative to the spindle of the machine and make it completely universal, it is arranged to interchange with the circular base on the vise, the zero line on the headframe corresponding with the zero line on the vise base, and as the center block carrying the spindle as well as the worm wheel are both graduated in degrees, complete universality is obtained. This machine has 36 inches of table feed, 12 inches of cross-feed and 19 inches of vertical feed; the drive pulley is 16 inches in diameter for 5-inch belt, and is built by the Kearney & Trecker Company, Milwaukee, Wis.

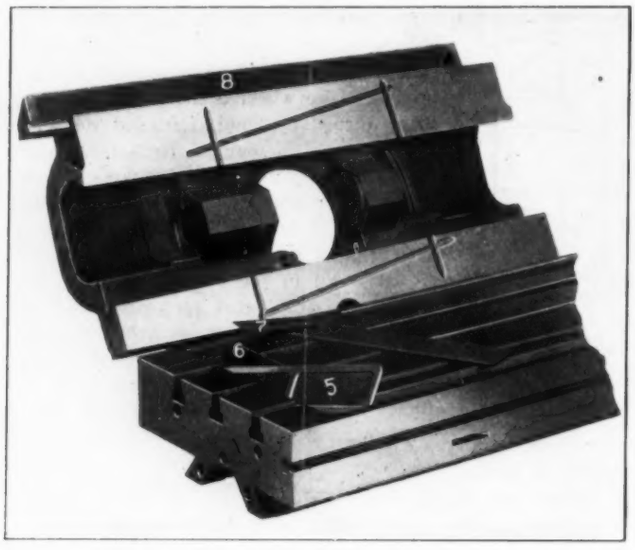


FIG. 4. DETAILS OF LUBRICANT CHANNELS IN TABLE

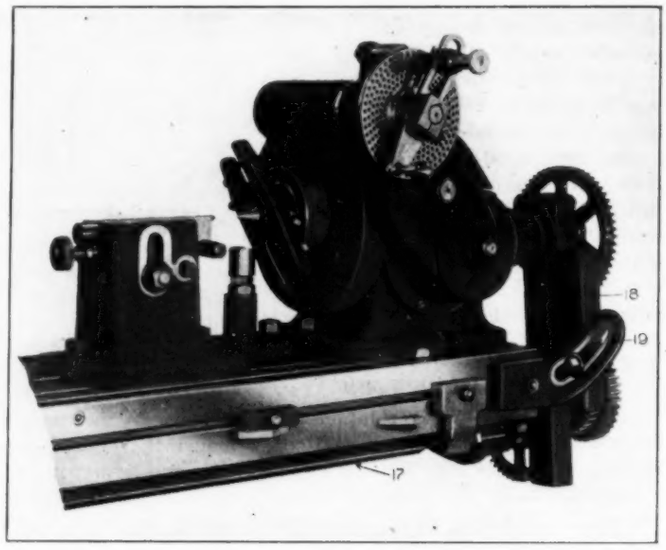


FIG. 5. THE NEW DIVIDING HEAD

Grinder with Constant Cutting Speed of Wheel

This differs from most grinders in not having water in the base of the machine, but in a large tank which holds a month's supply and which can be taken out of doors to be cleaned, the dirt being shoveled out if desired. This tank extends into the frame and avoids all packed joints and hand holes. A vertical centrifugal pump is used, avoiding the use of packing and being unaffected by dirt and grit.

GRINDER WITH CONSTANT CUTTING SPEED OF WHEEL

The rheostat or speed controller is connected to the water trap or movable piece in front of the hood, so that as this is moved in to be close to the wheel as it wears, the resistance is lowered and the wheel speeds up to give the proper cutting speeds for the smaller diameter.

The tool rest is perforated so that water can shoot through it instead of splashing. Rubber hose is used for connections in place of iron pipe with elbows and joints. An emery-wheel dresser is made to be mounted in place of the water trap and makes it easy to keep the wheel true. It carries a 20-inch wheel. The machine is built by the Ransom Manufacturing Company, Oshkosh, Wis.

Reversing Device as Applied to Planers

A mechanical reversing device, that will reverse any machine or machinery, without any shock either to the driver or the driven, is manufactured by the Conkling Company, of Chicago, Ill. They have, for some time, had one of these easy reversing clutches in operation on a planer, in their shop and it has given very good results in the practical work it has been called on to do. An easy reversing clutch is something that has been needed in mechanical lines, ever since mechanics were known and especially now, when electric motors are being used very extensively for an individual drive.

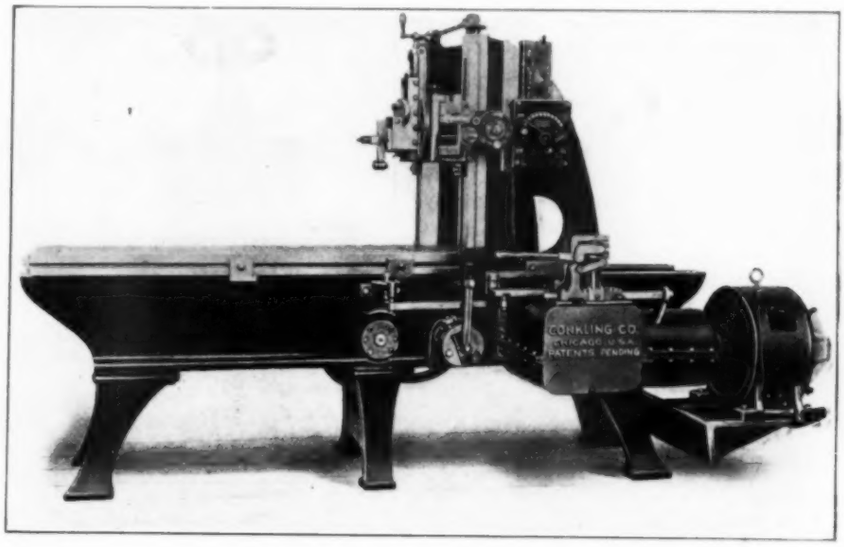


FIG. 1. MOTOR-DRIVEN PLANER WITH REVERSING DEVICE ATTACHED

We show herewith four views; Fig. 1 shows the planer with the device attached and driven by the motor direct. With this easy reversing clutch, the platen of planers ranging in size from 24 to 40 inches can be run on the backward stroke 200 feet per minute. Ordinarily, the platens of these sizes of planers are run on the backward stroke from 75 to 100 feet per minute. By using this easy reversing clutch, one can also obtain three or more different cutting speeds, without changing the backward stroke of the platen; or, in other words, one can have three or more different speeds and keep the backward stroke of the platen at 200 feet per minute for all three. As this device can be placed upon planers now in use, one can readily see what increased capacity the users of planers can obtain with this mechanical reversing device in connection with the direct motor drive.

Fig. 2 shows the device with the controlling yokes that move the reversing mechanism. The shaft shown at the right is coupled on the shaft of the planer; and

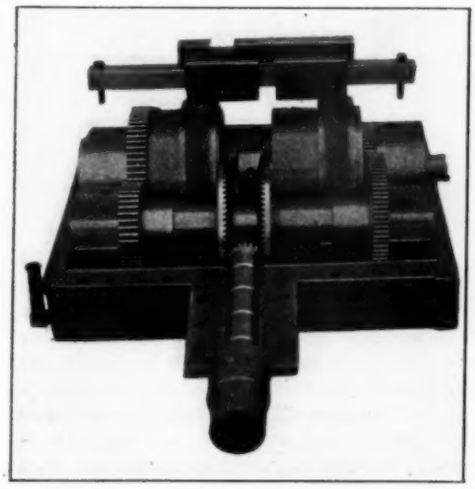


FIG. 2. REVERSING MECHANISM WITH COVER OFF

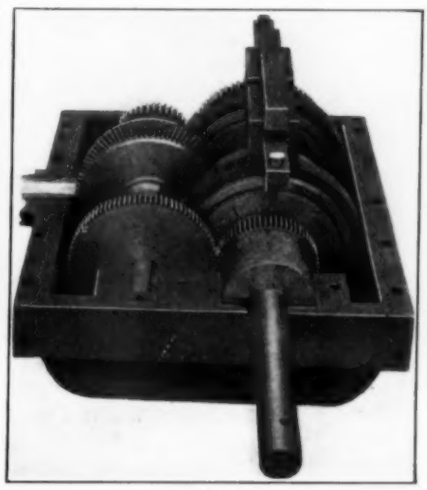


FIG. 3. END VIEW

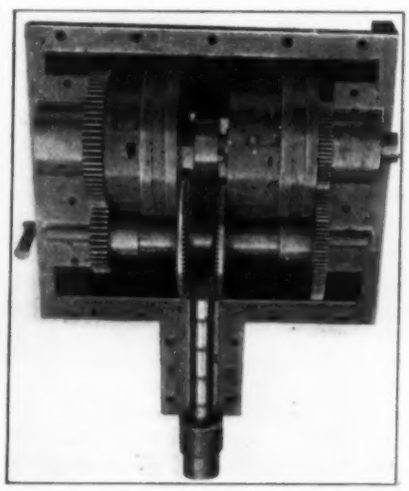


FIG. 4. TOP VIEW

the other shaft showing the four grooves, is connected to the motor. The beveled pinion runs one side of the mechanism in one direction and the opposite side in the other. The gear at the right runs the platen on the backward stroke and the smaller gear at the left runs it on the cutting stroke. The arrangement of the gears for the different cutting speeds, would be attached to or connected with the small gear shown at the left, near the oil gage glass, which shows the depth of oil that should be kept in the case, for this mechanism runs in oil in the inclosed case, as shown on the planer.

Fig. 3 shows an end view of this same mechanism, while Fig. 4 shows a top view with the controlling yokes taken off, which gives one a very good view of the reversing clutches. This device is not only adapted to machine planers, but to any mechanism requiring reversing, such as washers, automobiles, etc. It is self-adjusting and takes up its own wear.

A New Constant Angle Gear-hobbing Machine

This machine differs from other gear-hobbing machines in several ways, particularly in having the hobbing spindle set at a permanent angle instead of being adjustable. This angle is determined for

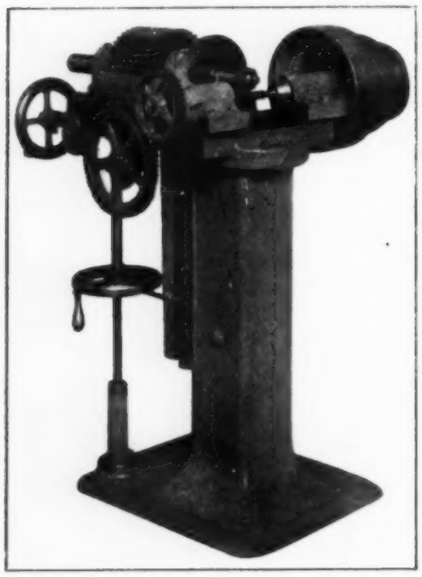


FIG. 1. A GEAR HOBBING MACHINE

one pitch with a certain diameter of hob and other angles are secured by increasing or decreasing the diameter of the hob itself. For finer pitches where the hob would be too small for practical purposes they are cut with a double thread.

As can be seen from Fig. 1, the hob is driven directly from the cone pulley and transmits the power to the gearing at the side of the machine, the last gear driving a master worm which engages with the broad-face master worm wheel, shown on the work spindle. This insures the gear blanks being revolved in unison with the hob. The blanks are fed forward by a train of gears going down from the back of the work spindle and turning the feed-screw, which can also be operated by the hand-wheel at the back. The whole work-carrying head can be moved vertically on the column by the hand-wheel shown, and this is graduated so as to make set-

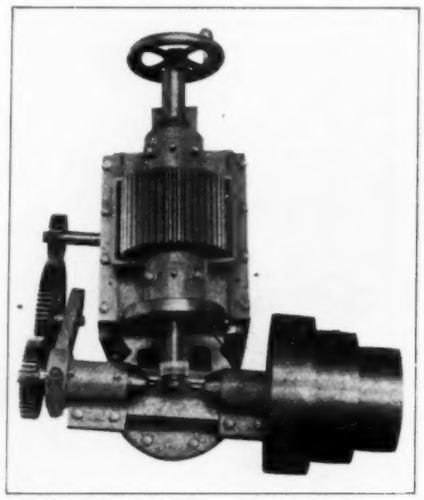


FIG. 2. TOP VIEW

ting for the proper tooth depth an easy matter.

Fig. 2 is a top view of the machine which shows the angle at which the hob is set and also that the master worm under the broad-face master worm wheel is at the same angle. This broad face allows the work spindle to be fed forward across the entire width of the master wheel, and makes a simple and novel worm-hobbing machine. The setting of the hob and the master-worm spindle permanently in line makes it an easy matter to change gears for any variation of pitch, so that the setting of the machine is as simple as that of an ordinary screw-cutting lathe. This machine is made in one size only, for cutting spur gears up to 12 inches in diameter by 6-inch face and up to 5 diametral pitch. It is made by the Moline Tool Company, Moline, Ill.

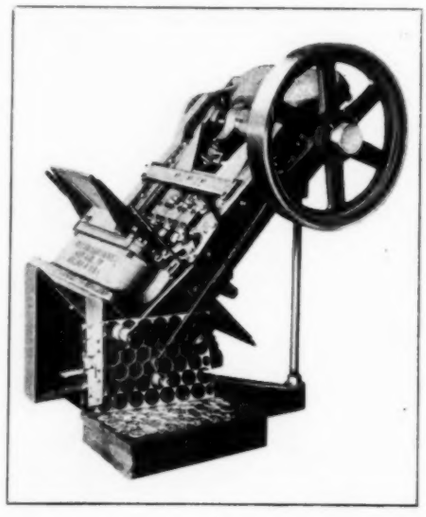
A Double Pitman Gang Press for Can Making

This is a double-pitman gang press, designed for operating a gang of six sets of dies for cutting out can tops or bottoms, and is set in an inclined position for the purpose of having the sheet of metal feed through by gravity. A cam-actuated shaft operates the gages for locating the sheet. These gages are raised automatically at the same time that the sheet is stripped from the punches after the cutting and forming operation is completed, permitting the sheet to slide forward where it is again correctly located for the following operation by the gages.

The hand lever, just visible on the left-hand side of the press, is used when first placing the sheet in the press, after which the press is started by the foot treadle in the regular manner, and runs continuously for the required number of strokes to finish the sheet. The press at this point is automatically stopped with a cam movement of the disk on the front right-hand side of housing which disengages the locking device for foot treadle, in this manner releasing the clutch. The vertical hand lever shown on the right-hand side enables the operator to instantly release the clutch mechanism at any stroke when required before the completion of the entire sheet.

An automatic positive knockout to the upper dies is provided by means of a stem or bar running down through the threaded plunger or sleeve previously referred to and connecting to the inner pad of upper die. Directly above this rod or bar and attached to the cross-bar running right to left, both in the front and rear of the press is the knockout arm. This arm is fitted with a screw and jam nut providing an independent adjustment for the knockout to each set of dies.

It is intended to notch the sheet to provide a proper accurate gaging surface at the same operation and stroke of the press in which the stampings are cut. In the



PRESS FOR MAKING TIN CAN TOPS

illustration shown, however, this operation is completed in a separate press which was provided for and is used to recover the small amount of scrap left in the three places at each end of the sheet out of which small stampings for rectangular can bottoms, as shown, have been cut.

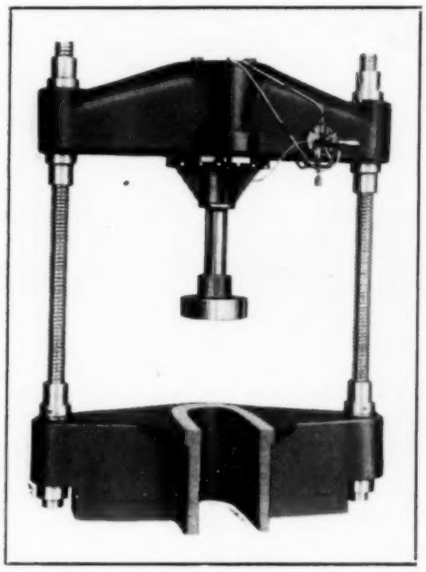
It is not required to square the sheets to prepare them for this press; in this manner an operation is avoided. The amount of waste or scrap is reduced to

the smallest minimum practical, and yet have the web of the sheet hold together to prevent clogging up or buckling in the dies, there being less than 1/16 inch of scrap between the cut opening.

This press has a capacity for producing at the rate of 200,000 pieces per day of 10 hours, and is manufactured by the Toledo Machine and Tool Company, of Toledo, Ohio.

A Pneumatic Shop Press with Two Air Pressures

This consists primarily of two heavy frame castings and two upright screws



PNEUMATIC SHOP PRESS

placed far enough apart to admit a 40-inch wheel or pulley being placed between them, and for varying the distance between frames. The opening in the base extends back beyond the center so as to allow arbors or shafting to be forced out. The upper frame contains a 12-inch air cylinder which permits an 8-inch stroke, although this could easily be made longer if found desirable. The lower end of the piston-rod carries a heavy shoe which has a babbitt center to prevent marring finished work.

Air pressure is supplied from the regular shop system and is controlled by the small valve at the right of the upper frame. This raises or lowers the piston as desired. This valve is rather unique as starting from the left-hand position the piston is raised, while a further movement of the handle shuts off the air. By passing the next point in the same direction the piston is lowered and the full air pressure applied to the work. Should this not prove sufficient a still further movement throws into operation a small, quick-acting, automatic air pump placed on the top of the frame, which is capable of raising the pressure to 250 pounds per square inch, although the main line supply is only 80 pounds. In other words, it trebles the ordinary pressure obtainable, 8800 pounds.

This is being built by the Springfield Machine Tool Company, Springfield, Ohio, having been designed by their superintendent, Paul E. Montanus, and has proved extremely satisfactory in their own shop.

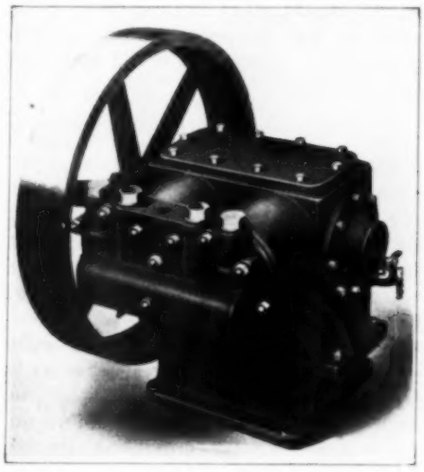
"The Imp" Gasolene Blow Torch

"The Imp" torch, manufactured by the Frank Mossberg Company, of Attleboro, Mass., is compact and simple. It is entirely automatic in operation, has no pump or valve, needs no tools, starts with a match and gives a clean, powerful Bunsen flame for over two hours on four ounces of gasolene. The corrugated neck increases the heating surface to such an extent that the flame of a match easily generates gas enough for starting, after which the specially designed mixing tube renders further attention unnecessary. See the accompanying illustration.

"THE IMP" GASOLINE TORCH

A New Air-brake Type of Air Compressor

The adaptation of the standard types of air compressors used with air-brake equipments to many industries requiring compressed air has been decidedly successful. The demand for them has broadened to such an extent that the Westinghouse Traction Brake Company, Pittsburg, Penn., has found it necessary to provide a line of belt-driven compressors for cases where the only power available is from shafting, or where it is not expedient to use either steam or electric motive power.



A NEW COMPACT AIR-BRAKE TYPE AIR COMPRESSOR

These compressors, designated as the Type F-B belt-driven air compressors, are made in four different sizes, viz., F-1-B, F-2-B, F-3-B, and F-4-B, having 15, 20, 44½ and 54½ cubic feet of free air per minute capacity, respectively, at standard speeds; 220 revolutions per minute for the F-1-B and F-2-B, and 200 revolutions per minute for the F-3-B and F-4-B compressors. The horse-power required to operate the compressor in the four different sizes at 100 pounds pressure is 3, 5, 9 and 11, respectively. See the accompanying illustration for an exterior view. Its compact design, the arrangement of the cylinders, position of the band-wheel base, and general ease of accessibility to all working parts are clearly shown. They will operate successfully against pressures up to 200 pounds per square inch, and may be had with or without water-jacketed air cylinders as occasion requires.

The F-B compressor is most compact in design, being similar in all respects to the motor-driven compressor except that the motor is replaced by a belt wheel keyed on the crank-shaft of the compressor. It is of the duplex, horizontal, single-acting type, portable and applicable to any industrial service.

The Dorman Tapping Attachment

The half-tone illustration, Fig. 1, shows a new tapping attachment for driving small taps known as the Dorman tapping attachment. It is being put on the market by John H. Dorman, 1 Bethune street, New York City.

It is intended for use in sensitive drills and will drive taps up to, and including, ⅜ inch in diameter. The bar projecting toward the right in Fig. 1 is brought in contact with the pillar of the drill and acts as a stop for the attachment. The rod bent to a right angle and shown intersecting the length of the tap is a stop for the depth of the tapped hole, registering from the surface from which the hole is tapped. The tapping speed is the same as the spindle speed of the drill press; the reverse speed is 1¼ times the spindle speed.

Construction of the Attachment

Fig. 2 is reproduced from a patent drawing. The taper shank, which has a No. 1 Morse taper, is screwed into a short spindle indicated by the letter *A*. This spindle has a collar or head that enters a recess in the gear *B*. Between this collar and the surface of the gear is a fiber friction washer. A second fiber friction washer is between the gear and the collar *C*. This collar is threaded through the spindle *A*, thus the drive between the taper shank and the gear *B* is through two friction washers that can be adjusted for the driving force required.

The chuck *D* is carried on a short spindle *E*, through which passes a floating clutch bar *F*. This spindle has a vertical motion of about ⅜ of an inch so that it can engage the gear *B* to drive the tap for tapping or the gear *G* in order to reverse the tap. The reversing and increase of speed are accomplished through three small gears, the arrangement of which is plainly shown. This clutch bar has conical seats to engage the clutch pins and minimize wear.

The case is made of aluminum, the cover plate is of cast iron, the gears are all of steel cut from the solid and the working spindles are of steel carefully ground.

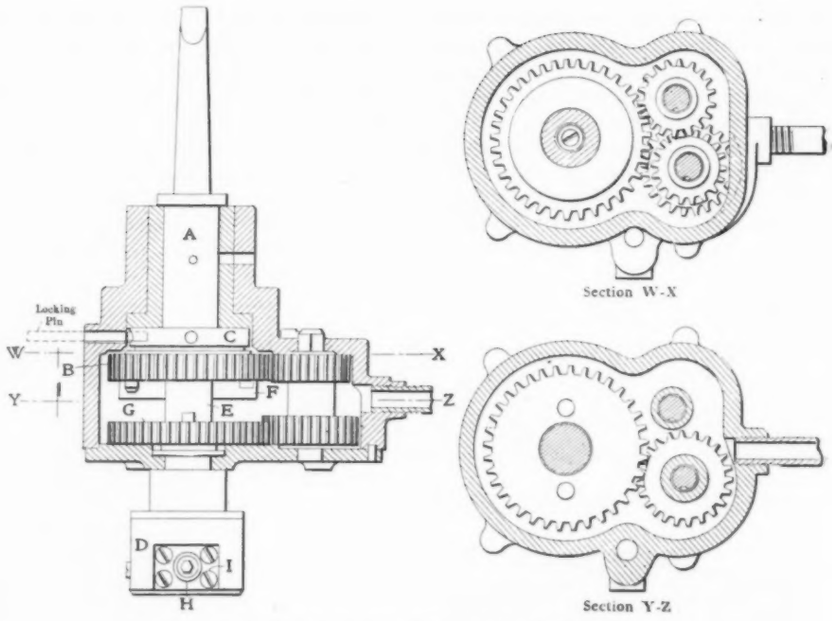


FIG. 2. DETAILS OF THE TAPPING ATTACHMENT

The Chuck

The chuck is of especial interest because of its simplicity. It consists of a chuck body indicated by *D* in Fig. 2 and a floating jaw *H*. This jaw is held in place by a small set-screw shown at the left-hand side so that it cannot fall out, but still has free motion back and forth in its slot. The lower end of the shank carrying the chuck body has a deep, tapered, center hole. When a tap is inserted in the chuck, its end is pushed up into this center hole and the shank is clamped in a V-slot in the floating jaw by means of the set-screw *I*, thus the chuck is self-centering and self-alining.

An interesting detail of design is the provisions for oiling. All of the working surfaces of the attachment are reached by

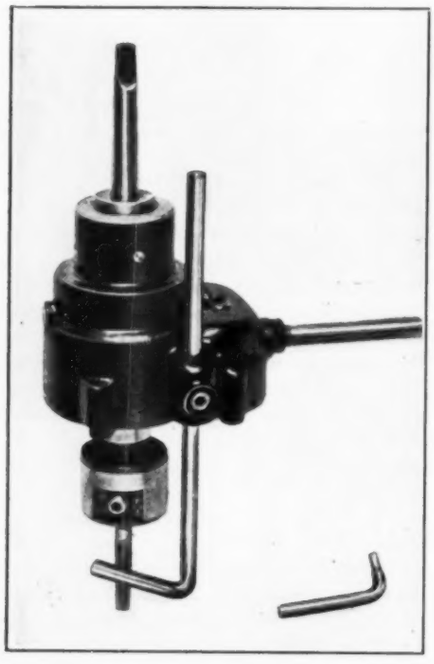


FIG. 1. THE DORMAN TAPPING ATTACHMENT

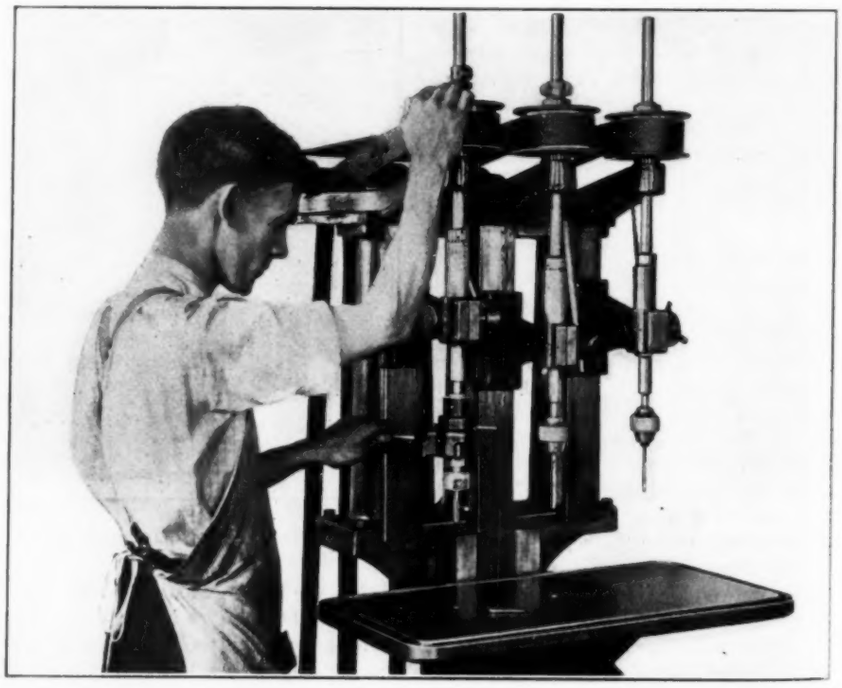


FIG. 3. METHOD OF ADJUSTING THE FRICTION DRIVE OF THE TAPPING ATTACHMENT

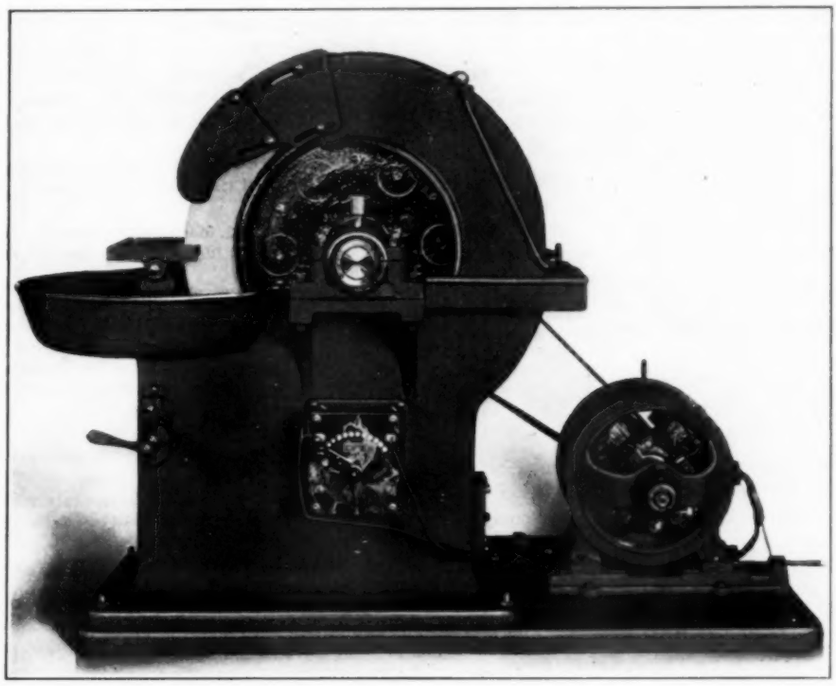
oil holes from the exterior. These holes are plainly marked with the word "oil" and there is no excuse for inattention in this particular on the part of the men.

The Friction Drive

The half-tone, Fig. 3, shows one of these tapping attachments in the spindle of a sensitive drill and an operator in the act of adjusting the friction drive. A pin indicated as the locking pin in Fig. 2 is inserted to the case into the nut *C*. With the attachment in place in a spindle of a drill, or with the tang of the taper shank caught in a vise, it is an easy matter to adjust the driving tension by using the stop pin as a wrench.

A Motor-driven Grinder with Sub-base

The motor used in this drive is of standard size and winding, the base and



MOTOR-DRIVEN WET GRINDER

the pulleys being so proportioned as to avoid the necessity of special apparatus. The tool rest can be tilted at any desired angle, and the large pan prevents splashing over the floor. The standard grinder is mounted on a sub-base long enough to include the grinder itself at the front and the motor at the rear, which has a sliding base to adjust tension on the belt. This places the motor out of the way as much as possible without putting it overhead in a position that might prove top-heavy. A door is provided in the hood at the back to allow grinding on that side, the apron preventing splashing over the motor. This is made by the Springfield Safety Emery Wheel Company, Springfield, Ohio.

Machine-tool Trade Opportunities in Brazil

By M. de Moreira

A great many American tool manufacturers are ignorant of the fact that Brazil is a progressive country where their goods will find a ready market. Unfortunately, now nearly all the machine tools there are of an antiquated pattern and mostly of German and English origin. In spite of this fact, it is nevertheless true that the Brazilian would rather favor American manufactures, as they seem to feel a kindred spirit for nations of the same hemisphere and also because American tools are more perfected.

Railroad Shops

The prevailing idea among American manufacturers is that there is no opportunity in South America for them. A few facts will convince them of the contrary: The Central Railway, of Brazil, is building now all its cars. That line, owned by the Government, is most important and possesses 305 locomotives. It runs from Rio to Sao Paulo and to Minas, and has all along its route well equipped repair shops. Its buildings and shops, though not large, are up-to-date, and the Government is increasing the amount of its machinery every day. The same thing can be said of the Nogyana railway, which has its own car factories; the Leopoldina railway, which operates 1423 miles of road, is constantly adding to its rolling stock, not by importation, but by home manufacturing.

Within the past year American interests, supported in a greater part by Canadian and French capital, have secured more or less perfect control of a system of rail and water transportation forming a belt line about the whole of the better portion of Brazil. This system, with the Government lines and the Government subsidized steamers, reaches nearly every portion of that great republic. This great system is composed of the Sao Paulo-Rio Grande railroad lines, the Amazon-Bolivian system and the Paraguay-Bolivian connections. The first reaches the coffee and the livestock district and connects them with the seaboard. The second connects Bolivia with the Atlantic by means of the Bolivian railways and rivers; the third connects the coast system with the Paraguayan railroad, thus reaching into Bolivia and thence into the valley country of South-Central Brazil.

Ship-building Plants

Regarding marine transportation, docks are now built in Rio, doing away with the necessity for steamers to anchor down the bay. We have read a few days ago of the great number of men-of-war ordered by Brazil in Germany and England. The newspapers have found in this fact a great political move, whereas any one familiar with South American matters understands very well the stand of Brazil in the matter of South American predominancy. Argentina and Brazil have never been very good friends and it is only natural for Brazil to try its best to be the sea-ruling power among South American republics. Ship building exists in Brazil on a larger scale than in any other South American republic. M. A. Lage has on the Ilha do Vianna, very well equipped shipyards where big launches, coasters and even men-of-war are built, and the Government has in all the ports arsenals and large repair shops, and naturally needs tools that can be supplied from American manufacturers.

In connection with this the Government in Brazil has just made arrangements for the construction of the largest dry dock in South America. By the plans finally adopted, 100,000 cubic meters of rock will be excavated from the bottom, sides and land end, until the dock will have a total inside length great enough to admit a vessel 815 feet long. It will be divided into three sections, one of 150 meters, one of 70 meters and the third of 30 meters, so that three vessels of proper size can be handled at the same time. The dock is to be fitted with all the latest appliances and will afford necessary conveniences for the docking and repairing of vessels up to 16,000 tons.

Street car companies in Rio de Janeiro and in Sao Paulo have their own car-building shops and a great part of the street cars used in the provincial towns are furnished from these shops.

Steel structures are also becoming popular in Brazil, especially in the port towns.

With the enlargement of the streets of Rio de Janeiro, the modern buildings erected now have nearly all steel structures; however, what steel is imported comes almost entirely from Belgian and German houses. Have Americans any fear to compete with these two nations?

FOUNDRIES AND MACHINE SHOPS

There are a great number of foundries and machine shops in Brazil; factories of different kinds are numerous considering not the territory but the population; the official statistics give the number of 2397 factories in Brazil having a capital invested of $163,349,000.

The province of Rio Grande manufactures iron safes, stoves and other iron foundry products. We all know that America manufactures the best safes in the world, still, looking over the safe export to Brazil during 1906, we see that out of $74,000 of safe export during that year, America figures in the great sum of $2000, the rest is distributed between France, England and Belgium.

The province of Sao Paulo needs agricultural implements and tools for manufacturing and repairing them; the province of Minas requires dredging and mining machinery for its diamond mines, which are increasing in value every day. Are we not able to furnish these?

ICE-MAKING PLANTS

Ice, a thing of absolute necessity, is another manufacture that could be picked up by the tongs, if the American manufacturer would only think of it. Let me quote you a passage of the report of our American consul in Brazil. "With the exception of a sailing ship's cargo of ice and apples received at Rio de Janeiro once a year, at Christmas time, the ice supply of that city is altogether artificial, and the price charged for the product is very high as compared with the cost of the manufacture. Artificial ice in Rio de Janeiro for public use is supplied by a single factory, more or less out of date in its equipment. The ice, which is of low cooling power, is distributed mostly to depots in corner groceries and thence sold in small quantities to consumers at about 2½ American cents per pound."

Fiber weaving also needs our attention, as a great quantity of machinery and tools are required to produce a satisfactory result for export.

All that I have said should make the American manufacturer think seriously and realize the great opportunity he has ignored and is ignoring.

AMERICA SHOULD ARRANGE TO GRANT CREDITS

One of the chief stumbling blocks in the extension of the American export trade in this country has been an indisposition on the part of American exporters to grant credits, due to the fact that American manufacturers have preferred to do business upon a cash basis with a lower margin of profit than upon a credit basis with a larger one. The extent of this change in the past year is illustrated in the statements of the foreign banks in Rio de Janeiro at the end of February, 1906, as compared with February, 1907. There was an increase in the amount of bills discounted of about $2,110,500; in bills receivable, of about $2,626,800; in bills and securities pledged, of about $2,825,700.

The present general method followed by most Brazilian houses is to buy on, say, six months' time, with interest at, say 10 per cent. from date of invoice. The jobber who thus purchases sells to the retailer on, say, three months' credit. The retailer sells for cash or arranges so that he can pay his bills at the end of the three months' credit. Thus the jobber and retailer do business with less capital than if their transactions were for cash. So long as interest charges in banks are higher than the rate of interest charged by the manufacturer or exporter on the original sale, this lack of capital has best been met by this credit system.

When banks loan money for the same rate or less than the manufacturers or exporters, it pays to discount bills and pay cash or take short-term credits. What change there has been in buying methods indicated in the bank reports referred to is likely to have been more in the direction of using the banks in place of the manufacturers or exporters, than in the way of any material change in financial conditions generally, although some have occurred.

Harris Tabor

Harris Tabor, consulting engineer of the Tabor Manufacturing Company, Philadelphia, Penn., with an international reputation in mechanical circles, died July 29, of an illness that is reported to have been brought about by an automobile accident a little over a year ago. A more detailed notice of Mr. Tabor's career and business life will appear in the columns of next week's issue.

Inquiries for Machinery

(188). Would like to know maker of counting machine bearing patent No. 503,773, which was issued November 16, 1897.

(189) Would like to know names of builders of machinery for making horseshoe nails.

Business Items

Patterson, Gottfried & Hunter have removed from 146 Center street to 211-215 Center street, New York City.

Harrington, Robinson & Company, 272-276 Franklin street, Boston, Mass., have been appointed New England agents for the "Toledo" high speed steel.

The Toledo Machine and Tool Company have recently received large orders for punch presses and drop hammers. Their plant is now turning out about 80 per cent. of its normal capacity.

Trade Catalogs

Rockwell Furnace Company, 26 Cortlandt Street, New York. Circular illustrating and describing enameling furnaces.

Hart & Cooley Company, New Britain, Conn. Catalog B, describing metal lockers. Illustrated, 32 pages, 6x9 inches, paper.

American Spiral Pipe Works, Chicago, Ill. Pamphlet No. 22, describing Taylor spiral riveted pipe. Illustrated, 16 pages, 7½x10 inches, paper.

Business Opportunities

The Dexter Yarn Company, Pawtucket, R. I., is erecting an addition to its mill.

The Blount Plow Works, Evansville, Ind., has purchased a site for a new plant.

A. T. Zentmyer, Hagerstown, Md., will establish foundry to replace present plant.

The Claxton (Ga.) Foundry and Machine Works will rebuild plant recently burned.

The Detroit (Mich.) Column and Manufacturing Company will erect a new plant.

It is reported that the Kidder Press Company, Dover, N. H., will enlarge its plant in the near future.

The Union Hardware Company, Torrington, Conn., has increased its capital and will enlarge its plant.

The Star Drill and Machinery Company, of Akron, Ohio, is erecting a branch factory at Portland, Ore.

The Memphis (Tenn.) Button Works is being incorporated to manufacture pearl buttons. Capital, $100,000.

It is reported that the carshops of the Chicago, Milwaukee & St. Paul Railroad will be located at Tacoma, Wash.

Farmers' Oil Mill, Gaffney, S. C., will erect a 20-ton oil mill and ginnery. H. R. Eichberg, engineer in charge.

The Junction City (Ga.) Manufacturing Company is planning to manufacture stoves, ranges and hollow ware.

The Nottoway (Va.) Manufacturing Company contemplates developing water power and installing an electric plant.

The Pratt Chuck Company, Frankfort, N. Y., will erect an addition to its plant, which will increase the capacity one-third.

The car repairs shops of the Iron Mountain Railway Company, at Van Buren, Ark., will be removed to Fort Smith, Ark.

The Columbia Meter Company, Indianapolis, Ind., has been incorporated to establish a plant for the manufacture of electric and other meters.

The Rock Island (Ill.) Tool Company, will, it is said, consolidate its two plants and build a new factory, site for which is being negotiated for.

J. E. Hellams Canning and Preserving Company, Gordo, Ala., is erecting two-story building; canning and preserving machinery will be installed.

The Wambold-Brunschweiler Company, Milwaukee, Wis., brass founders and supply agents, has secured a site for a foundry, offices and finishing shop.

The Western Steel Car and Foundry Company, of Chicago, Ill., is taking estimates on an addition to its plant at Hegeswisch. It is said the cost will be about $200,000.

The Detter Canning and Packing Company, Oklahoma City, Okla., recently incorporated,

will establish a temporary plant and later will erect a permanent plant.

The Wabash-Pittsburg Terminal Railway Company and the West Side Belt Railroad Company will construct shops at Rook, Penn. H. T. Douglas, Jr., Pittsburg, is chief engineer.

Weyman & Connors, Atlanta, Ga., have purchased the Helena (Ala.) Rolling Mills and Pipe Works and will convert same into a plant for the manufacture of steel hoops and cotton tires.

The Phillips Manufacturing Company, Winter Park, Fla., making woodworking machinery, will move to Orlando, where a new building will be erected and additional machinery installed.

Lewis F. Parker, of Greenville, S. C.; St. John Courtney, of Newry, S. C., and J. F. Fleitmann, of New York, are organizing a company to establish a $300,000 Cotton mill at Spartanburg, S. C.

The Mattatuck Manufacturing Company, Waterbury, Conn., will erect a new factory adjoining the present one. The company manufactures handcuffs and other metal specialties.

The Ford Motor Company, Detroit, Mich., has completed plans for a new plant, to consist of main building four stories high, power house, office building, etc. About 5000 men will be employed.

The International Steam Pump Company, 115 Broadway, New York, is sending out inquiries for machine tools for its various plants. It is said about $100,000 will be expended in this direction.

The Universal Rolling Mill Company, Washington, Penn., has been organized to manufacture steel sheets and plates. Capital $75,000 H. B. Duncan, N. R. Baker, of Washington, and others, organizers.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m. August 24 for steel flat cars, push and hand cars, track gauges and levels, jacks, nut-lock washers, bolts, bitts, breast drills, rock drills, hose, hose clamps, taps, stocks and dies, copper ferrules, drawer locks, carborundum wheels, wire, electrical material, dry batteries, lubricating grease, etc. as per Circular No. 459.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will receive the following bids: August 11—Barometers and binoculars (schedule 148), portable boilers, brass pipe (schedule 160), breast drill, calipers (schedule 158), electrical fans (schedule 147), drawing instruments (schedule 148), steam kettles (schedule 157), August 18—Rubber and leather belting, twist drills (schedule 177), electrical supplies (schedule 144), nickel steel forgings (schedule 162), cast-iron ells, lead pipe, iron pipe, globe valves, regulating valves (schedule 165). August 25—Slotting attachment, gang drill, roll former, internal grinder, turret lathe, profiling machine (schedule 170), engine lathes, boring and milling machine, milling machine, geared planers (schedule 171), engine lathe (schedule 173), rod machines, plug machines (schedule 172), spare parts for drills and hoists (schedule 143), pipe and fitting (schedules 138, 141, 144).

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Small, accurate drill jigs and dies built to order. R. Rosner, Madison, Wis.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

High power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Machinery or machine parts to build by contract. Ideas developed; drawings made. Address "A," care AMER. MACH.

Tools—Send your name and address on postal for our net priced catalog. Every machinist should have it. Montgomery & Co., 105 Fulton St., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Which company have on stock or build special machinery for manufacturing horseshoe nails? Address full offers to T. M. Apstein & Sone, Kiew, Russia, Kresczatik No. 2.

A large mercantile corporation in a large western city is offering some preferred stock. It is a conservative and safe investment. Full particulars on request. Box 355, AM. MACH.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Drawings, designing special and automatic machinery, inventors' ideas developed, by mechanical engineer of long experience. First-class references. H. W. Cole, 453 Third St., Brooklyn, N. Y.

Tomey's Scotch gauge glasses, made at Tay Glass Works, Perth, Scotland, are sold by Montgomery & Co., 105 Fulton St., New York City. Beware of imitations, and don't take the "just as good as —."

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris streets, New York City.

A large concern manufacturing centrifugal pumps desires to secure reputable machinery houses to act as agents on commission basis in the following cities; Baltimore, Washington, Hartford, Providence, Boston, Portland, Maine; Harrisburg, Pa., and Rochester. Communicate at once to Box 339, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

High grade superintendent wants good position. Up in recent shop methods in all departments and cost systems. Energetic, executive, a handler of help and a producer. Box 349, AMERICAN MACHINIST.

Position as superintendent; 12 years' experience as superintendent and assistant; excellent executive ability; expert designer of tools, fixtures and special machinery; specialty light high grade interchangeable work. Box 345, AMERICAN MACHINIST.

FLORIDA

Position as superintendent or master mechanic. Up-to-date hustler, wide experience, good character and references. Address Box 316, AMERICAN MACHINIST.

ILLINOIS

Designer with experience on machine-tools, special manufacturing machinery, jigs, and fixtures, desires position. Box 360, AM. MACH.

Designing engineer, specialty engines, compressors, etc.; technical graduate; twelve years' experience, desires position. Box 340, AMERICAN MACHINIST.

INDIANA

Foundry superintendent of great executive ability who thoroughly understands practically an iron foundry in all its departments and making one pay, is familiar with a great variety of castings in loam, dry and greensand, mixing iron by analysis, economical cupola practice, wishes to hear from parties who can appreciate a man who can make money for them. Eighteen years superintendent and foreman. First-class references. Box 331, AMER. MACH.

MASSACHUSETTS

Expert designer and draftsman on special and automatic machinery. Practical machinist, good technical education, 12 years' experience, A-1 references, desires position. Address Box 361, AMERICAN MACHINIST.

Superintendent, good executive, up on cost and production. Technical and practical man, ten years' experience and has always got good results by original money saving methods. Address Box 323, AMERICAN MACHINIST.

NEW JERSEY

Chief draftsman and designer desires change. Address Box 320, AMERICAN MACHINIST.

A mechanical engineer, chief draftsman and designer, of executive ability and experience, desires engagement. Box 358, AM. MACH.

Competent, experienced mechanical draftsman, 28, technical graduate, desires change at $21.00 to start. A. Werner, 228 Clark Place, Elizabeth, N. J.

Practical man, age 30, shop and drawing room experience. Last six years superintendent's assistant, desires responsible position. References. Box 350, AMERICAN MACHINIST.

Foreman toolmaker wants responsible position. First-class designer of dies, tools, jigs and labor-saving devices of any description. Long experience as executive and modern shop methods. Box 329, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman, experienced, wishes position. References. Box 336, AMER. MACH.

Thoroughly experienced mechanical superintendent desires change. Address Box 357, AMERICAN MACHINIST.

Draftsman and designer, 25, on different classes of machinery, desires position. Box 352, AMERICAN MACHINIST.

Mechanical draftsman, expert practical man, eight years' experience, desires position. Box 362, AMERICAN MACHINIST.

Toolmaker, 23 years, accustomed to high grade all around work, desires steady position. Box 359, AMERICAN MACHINIST.

Mechanical engineer, college-graduate, one year shop and four years' drafting experience, wants position. Box 347, AMERICAN MACHINIST.

Mechanical draftsman, technical graduate, with three years' experience, wants position. Structural work preferred. Address Box 344, AMERICAN MACHINIST.

Tool and diemaker with 14 years' experience wishes permanent position. Can handle help and make working drawings. Country place preferred. Box 351, AMERICAN MACHINIST.

Wanted—Mechanical superintendency. One of the live ones, up to the minute in modern shop practice. Any location. Ready for engagement at once. Box 337, AMERICAN MACHINIST.

Inventor and engineer; highest standing as developer and designer of machinery. Man of business and character, with one concern past 10 years, wants situation. Box 354, AMERICAN MACHINIST.

First-class machinist and draftsman, 29, single, automatic machine, experimental, shop tools, etc., desires position as assistant to superintendent. Have held similar position. Box 341, AMERICAN MACHINIST.

Mechanical engineer, marine, designer and inventor; expert on steam, gas and petroleum engines; possessor of valuable improvements in gas engines, wants position where ability and experience count. Box 353, AMERICAN MACH.

Young mechanical engineer and draftsman, 30 years, desires position assistant to superintendent. Good executive ability and extensive experience in the handling of men. Best references. Good reason for desiring to change. Box 342, AMERICAN MACHINIST.

Assistant superintendent desires change; technical man with fifteen years' experience in the manufacture of sewing machines and fireams. Expert in the designing of special and automatic machinery, small tools, etc. Age 38. Address Box 322, AMERICAN MACHINIST.

OHIO

Wanted—Position as general foreman. Ten years' shop experience, technical graduate, reference furnished, married, will go anywhere. "L. B. S.," care AMERICAN MACHINIST.

PENNSYLVANIA

Designer on special machinery, now employed, desires change to position of greater responsibility. Box 348, AMERICAN MACHINIST.

Student in I. C. S. has finished mechanical

engineering course, desires position as draftsman or in shop. Age 22. Box 346, AM. MACH.

Expert cost accountant and systematizer desires an executive connection with manufacturing concern. Up-to-date methods and satisfactory results guaranteed. Box 304, AMERICAN MACHINIST.

RHODE ISLAND

An energetic, hustling, up-to-date foundry foreman desires to make a change. Well up on light and heavy work; expert on molding machines and cupola practice. Address Box 343, AMERICAN MACHINIST.

WISCONSIN

Position as superintendent by a high grade practical man. Organizer, systematizer, executive. Box 299, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Draftsman wanted. One who has had experience in a.c. and d.c. mechanical design. Apply by letter to the undersigned, stating age, experience, references and salary expected. Canadian General Electric Co., Ltd., Peterboro, Ont.

COLORADO

I want a genuine patternmaker that is not afraid of work. Pay according to worth. Address Box 335, AMERICAN MACHINIST.

ILLINOIS

Wanted—Man as working foreman experienced in producing fine goods from sheet german silver. Must thoroughly understand dies, diesetting and general shop practise. Must be energetic and able to produce big results at a minimum cost without friction. Highest pay for the highest efficiency. Nothing else wanted. Box 315, AMERICAN MACHINIST.

INDIANA

Wanted—An experienced foreman for machine shop manufacturing gasolene motors. Address Box 334, AMERICAN MACHINIST.

KANSAS

Wanted—High-grade machinist who thoroughly understands operating roll corrugating machine. Great Western Mfg. Co., Leavenworth, Kansas.

MASSACHUSETTS

Machinist wanted with experience as toolmaker and foreman. Golding Mfg. Co., Franklin, Mass.

First-class mechanical designer for electrical and mechanical instruments wanted in manufacturing establishment in Massachusetts. State age, education, past experience and salary expected. Address Box 356, AMER. MACH.

First-class designer of jigs and fixtures wanted for permanent position in Massachusetts. Only experienced, capable man need apply by stating age, education, previous experience and salary expected. Address Box 312, AMER. MACHINIST.

NEW JERSEY

Salesman—Wanted, an experienced travelling salesman familiar with printing machinery. Only first-class men with ability need apply. Fullest information, previous experience, age, and salary expected must be given. Apply by letter only to Walter Scott & Co., Plainfield, N. J.

NEW YORK

Wanted—Experienced operator on Gisholt lathe; none other than experienced operator, need apply. E. W. Bliss Company, Brooklyn N. Y.

Wanted—A first-class mill supply salesman to sell mill supplies in central New York. Reply giving experience, age and salary to start. P. O. Box 125, Syracuse, N. Y.

Wanted—Foreman of milling machine department in large automobile factory; must be a hustler and produce results by use of high-speed cutters and modern methods. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Wanted—A first-class brass worker and finisher, one familiar with press work, capable of running screw machines; also must understand managing shop of lamp burner factory. Send reference. Box 338, AMERICAN MACH.

PENNSYLVANIA

Wanted—Foreman for modern foundry making engine castings; capacity 20 to 25 tons. A very desirable place for the right man. Box 319, AMERICAN MACHINIST.

Foreman for erecting heavy machine tools; must be experienced on accurate machine tool work, with ability to increase production and efficiency; state age, experience and salary expected. Box 278, AMERICAN MACHINIST.

For Sale

Castings and prints for 8-inch foot lathe. W. E. Morey, 2563 Trink St., Chicago, Ill.

Old-style Wheeler planer, 22x5′, $150.00; 1 Fitchburg shaper, 12x16″, $35.00; 1 small wet tool grinder, $20.00. Samuel M. Langston, Camden, N. J.

For Sale—Manufacturing plant equipped with electric power, machine, boiler, blacksmith, pattern, woodworking shops. Foundry and storage, with machinery, tools and stock, or plant only. Railroad switch in yard. Shipping facilities by rail, lake or canal. Address Box 318, AMERICAN MACHINIST.

Small Tools—A very complete outfit of small tools, including calipers, micrometers, gages, drills, reamers, taps, dies, wrenches, hammers, squares, bevels, lathe tools, as well as an assortment of carpenters' and pipers' tools, suitable for a repair shop, tool room, or foreman. Will sell entire lot or divide as desired. All are of the very best quality, and in good condition, many being entirely new. Address Box 113, Southbridge, Mass.

Machinery for sale at the Kokomo, Indiana, Works of the Pittsburgh Plate Glass Company. 1 L. H. 30x60 E. P. Allis girder frame Corliss engine, 24′ fly-wheel; 1 L. H. 10x30 E. P. Allis girder frame Corliss engine, 12′ fly-wheel; 1 G. F. Blake 9x20x12 duplex vertical air pump; 1 E. P. Allis vertical surface condenser, 2700 sq.ft.; 1 15x18 high speed piston valve Beck engine; 1 10x18x14 tandem compound self-oiling Fisher automatic engine; 1 14x10x12 Smith-Vaile duplex steam pump; 1 R. H. Rankin & Fritsch 14x20 Tangye frame slide valve engine; 1 L. H. Rankin & Fritsch 14x20 Tangye frame slide valve; 1 13x20 box bed R. H. Mansfield throttling engine; 1 12x20 box bed L. H. Mansfield throttling engine; 7 14x24 Atlas box bed slide valve engines L. H.; 7 14x24 Atlas box bed slide valve engines R. H.; 1 Laidlaw-Dunn-Gordon 14x22x18 duplex air compressor; fly-wheel type air cylinder, unjacketed; 1 Dean Steam Pump Co. 12x7x10 duplex pump, just out of repair shop; 1 6x4x6 Worthington duplex steam pump; 1 Dean Steam Pump Co. 10x6x10 duplex steam pump; 8 Cahall vertical water tube safety boilers, 250 h.p. each. Inquire about above of W. D. Hartupee, 2d Vice Pres, Pittsburgh Plate Glass Co., Frick Building, Pittsburgh, Pa.

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Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts and Nuts
Electric Welding Products Co., Cleveland, Ohio.
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Technical
Hill Publishing Co., New York.
Sames, Chas. M., Jersey City, N. J.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Western Tool & Mfg. Co., Springfield, Ohio.

Boxes, Tote
Lyon Metallic Mfg. Co., Aurora, Ill.

Box Tools, Roughing
Bardons & Oliver, Cleveland, O.

Brazing
Industrial Oxygen Co., New York.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers
Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calculator, Slide
Dodge Mfg. Co., Mishawaka, Ind.

Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.
Wells, F. A., Waukesha, Wis.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels.

Carborundum Paper and Cloth
Carborundum Co., Niagara Falls, N. Y.

Case-Hardening
American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Castings, Brass and Bronze
Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Taylor & Fenn Co., Hartford, Conn.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.

Cast Iron Brazing
Industrial Oxygen Co., New York.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
National Machine Co., Hartford, Conn.

Centering Machines—*Cont.*
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Fay & Scott, Dexter, Me.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianopolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill
Almond Mfg. Co., T. R., Ashburnham, Mass
Brown & Co., R. H., New Haven, Conn.
Celfor Tool Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams & Co., J. H., Brooklyn, N. Y.

Clocks, Watchman's
Hardinge Bros., Chicago, Ill.

Clutches, Friction
Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Williams Foundry & Machine Co., Akron, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Compound, Core
Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Bury Compressor Co., Erie, Pa.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Electric Welding Products Co., Cleveland, Ohio.
Standard Connecting Rod Co., Beaver Falls, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Owen Machine Tool Co., Springfield, Ohio.
Schaeffer Mach. Wks., Phila., Pa.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Work
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.